

# SMAP<sup>®</sup> - W3

Structure Medium Analysis Program

3-D Seepage Analysis

User's Manual Version 7.07

COMTEC RESEARCH



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**Contents****1. Introduction**

1.1	Overview . . . . .	1-1
1.2	Features . . . . .	1-1
1.3	Application. . . . .	1-3

**2. Installing SMAP-W3**

2.1	Minimum System Requirements. . . . .	2-1
2.2	Installation Procedure . . . . .	2-1

**3. Running Programs**

3.1	Introduction . . . . .	3-1
3.2	RUN Menu . . . . .	3-4
3.2.1	SMAP . . . . .	3-4
3.2.2	Mesh Generator. . . . .	3-6
3.2.3	Load Generator. . . . .	3-7
3.2.4	PlotXY Generator . . . . .	3-8
3.2.5	Command Line . . . . .	3-8
3.2.6	Windows Explorer . . . . .	3-8
3.2.7	Swcc Analysis . . . . .	3-8
3.3	PLOT Menu . . . . .	3-9
3.3.1	XY. . . . .	3-9
3.3.2	MESH. . . . .	3-9
3.3.3	RESULT. . . . .	3-10
3.4	SETUP Menu . . . . .	3-11
3.4.1	General Setup. . . . .	3-11
3.4.2	PLOT-XY Setup. . . . .	3-13
3.4.3	PLOT-2D Setup. . . . .	3-15
3.4.4	PLOT-3D Setup. . . . .	3-16
3.5	Manual Procedure to Run SMAP-W3 . . . . .	3-17
3.6	Debugging SMAP-W3 Main-Processing Program. . . . .	3-18

**4. SMAP-W3 User's Manual**

4.1	Introduction . . . . .	4-1
4.2	Project File . . . . .	4-2
4.3	Mesh File . . . . .	4-3
4.4	Main File . . . . .	4-9
4.5	Post File . . . . .	4-22
4.5.1	PLOT-2D . . . . .	4-95
4.5.2	PLOT-XY. . . . .	4-117

**5. Group Mesh User's Manual**

5.1	Introduction . . . . .	5-1
5.2	Group Mesh Generator. . . . .	5-2
5.3	Group . . . . .	5-2
5.4	Base Mesh . . . . .	5-15
5.5	Segment . . . . .	5-17
5.6	Modifying Finite Element Meshes . . . . .	5-22
5.7	Entities . . . . .	5-29

**6. Block Mesh User's Manual**

6.1	Introduction. . . . .	6-1
6.2	Block Mesh Generator. . . . .	6-2
6.3	Work Plane. . . . .	6-5
6.4	Entities . . . . .	6-20
6.5	Block. . . . .	6-31
6.6	Modifying Finite Element Meshes . . . . .	6-53

**7. PRESMAP User's Manual**

7.1	Introduction . . . . .	7-1
7.2	PRESMAP-2D	
7.2.1	MODEL 1 . . . . .	7-3
7.2.2	MODEL 2 . . . . .	7-15
7.2.3	MODEL 3 . . . . .	7-27
7.2.4	MODEL 4 . . . . .	7-35
7.3	NATM-2D. . . . .	7-39
7.4	CIRCLE-2D. . . . .	7-51
7.5	PRESMAP-3D. . . . .	7-55
7.6	CROSS-3D. . . . .	7-63
7.7	GEN-3D. . . . .	7-79
7.9	PRESMAP-GP. . . . .	7-97

**8. ADDRGN User's Manual**

8.1	Introduction . . . . .	8-1
8.2	ADDRGN-2D . . . . .	8-5
8.3	ADDRGN-3D . . . . .	8-25

<b>9. SUPPLEMENT Program</b>	
9.1 Introduction . . . . .	9-1
9.2 EDIT . . . . .	9-1
9.3 XY . . . . .	9-1
9.4 CARDS . . . . .	9-8
9.5 SHRINK FILE . . . . .	9-8
<b>10. File Conversion</b>	
10.1 Introduction. . . . .	10-1
10.2 Conversion to SMAP-W3 Mesh File . . . . .	10-1
<b>11. LOAD User's Manual</b>	
11.1 Introduction . . . . .	11-1
11.2 LOAD-2D	
11.2.7 LDTYPE=7 Seepage Analysis for SMAP-W2 . . . . .	11-41
11.3 LOAD-3D	
11.3.7 LDTYPE=7 Seepage Analysis for SMAP-W3. . . . .	11-101
<b>12. XY Graph User's Manual</b>	
12.1 Introduction . . . . .	12-1
12.2 New Graph . . . . .	12-3
12.3 Edit Dialog . . . . .	12-6
12.4 Existing Graph . . . . .	12-10
12.5 Excel XY Graph . . . . .	12-11
12.6 SMAP Result . . . . .	12-13
12.7 PlotXY Generator. . . . .	12-15
<b>13. PLOT-XY User's Manual</b>	
13.1 Introduction . . . . .	13-1
13.2 Menus . . . . .	13-2
<b>14. PLOT-2D User's Manual</b>	
14.1 Introduction . . . . .	14-1
14.2 Menus . . . . .	14-2
<b>15. PLOT-3D User's Manual</b>	
15.1 Introduction . . . . .	15-1
15.2 Menus . . . . .	15-2
15.3 Toolbars. . . . .	15-18
<b>16. SWCC User's Manual</b>	
16. Swcc . . . . .	16-1



## Introduction

### 1.1 Overview

SMAP-W3 is an advanced three-dimensional finite element computer program developed for the steady-state and transient seepage analyses. The program has been applied to various types of seepage problems. The program has been designed to integrate the pre-, main-, and post-processors as shown at the end of this Section.

### 1.2 Features

#### Features of SMAP-W3 include:

- Three-dimensional isoparametric element.
  - Models unsaturated and saturated soils and rocks.
  - Allows nonlinear hydraulic conductivities and water capacities with consideration of analytical models of van Genuchten and Fredlund and Xing as well as user specified tables.
- Earth dam mesh generator
  - Builds finite element meshes for the typical earth dams including cores and cut-off walls.

- Boundary conditions
  - Prescribed total head or pressure
  - Prescribed water flow
  - Potential seepage face
- Water generation sources
- Relaxation method for convergence of solution during iteration

### **1.3 Applications**

#### **Applications of SMAP-W3 include:**

- Slope stability
- Earth dam safety
- Foundation design
- Ground water management
- Construction dewatering
- Contaminant transport

## Overview of SMAP-W3 Program Structure

- USER INPUT** User prepares Mesh, Main, and Post Files according to SMAP-W3 User's Manual as described in Section 4.
- PRESMAP** Pre-processors to automatically generate Mesh File which contains nodal coordinates, boundary constraints, and element indexes.
- SMAP-W3** Main-processor executing Mesh and Main Files to compute water flow. Output files include:  
CONTSS.DAT Water pressures in elements  
DISPLT.DAT Total head, pressure & flow rate at nodes
- PLOT-XY** Post-processors executing Post File for graphical output:
- PLOT-2D**
- PLOT-3D**
- Finite element mesh
  - Contours of total head and water pressure
  - 3D iso surface of total head and water pressure
  - Time histories of total head and water pressure
  - Profiles of flow velocity



## **Installing SMAP -W3**

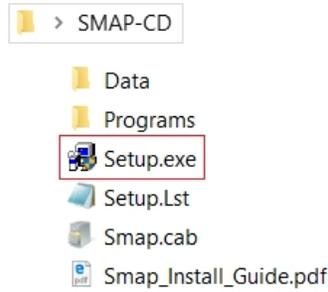
### **2.1 Minimum System Requirements**

- ✓ Windows 64 bit operating system
- ✓ Intel Pentium 4 or AMD processors
- ✓ 4 GB Ram with 30 GB free space in Drive C
- ✓ SVGA monitor

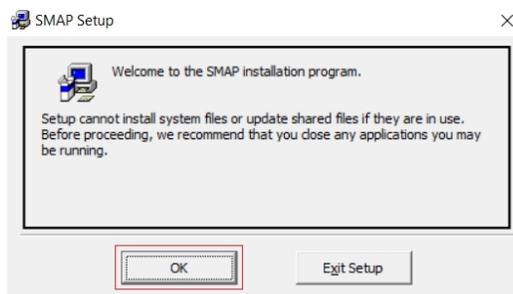
### **2.2 Installation Procedure**

1. Uninstall if there are pre-existing SMAP programs.  
To uninstall SMAP programs, remove following program using Add/Remove in Control Panel:  
SMAP  
Delete following files if they exist:  
C:\Program Files\Smap  
C:\Windows\Setup1.exe  
Rename or delete following folders if they exist:  
C:\SMAP  
C:\SmapKey
2. Download SMAP-CD.exe from the Download section of [www.ComtecResearch.com](http://www.ComtecResearch.com)
3. Run SMAP-CD.exe  
SMAP-CD folder will be created with SMAP installation programs

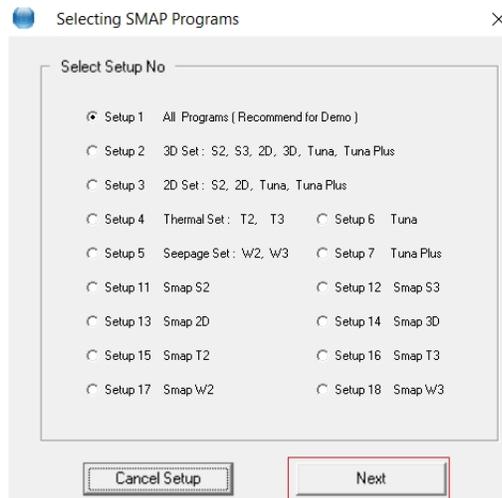
4. Double-click **Setup.exe**



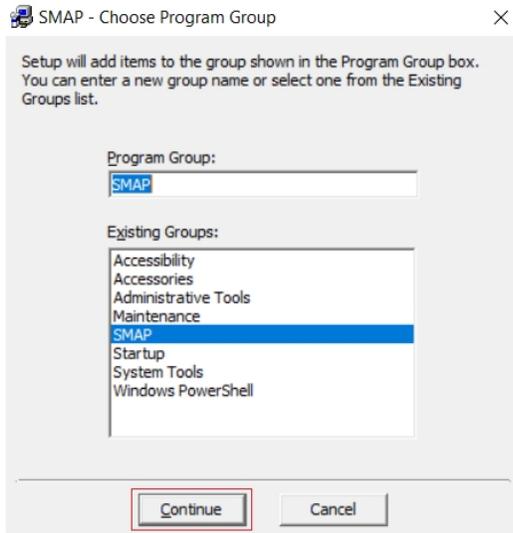
5. Click **OK**



6. Click **Next**  
It will take few minutes.  
Wait until next step.



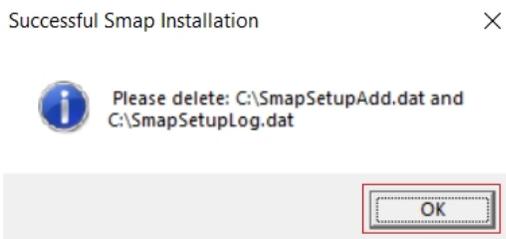
7. Click **Continue**



8. Click **OK**



9. Click **OK**



Note:

Following two log files will be generated once finished:

C:\SmapSetupAdd.dat

C:\SmapSetupLog.dat

If Smap Installation is successful, delete these two files.

If Smap Installation is not successful,  
follow the instruction in SmapSetupAdd.dat.

If you still have problems with Smap Installation,  
send these two files to [info@ComtecResearch.com](mailto:info@ComtecResearch.com)

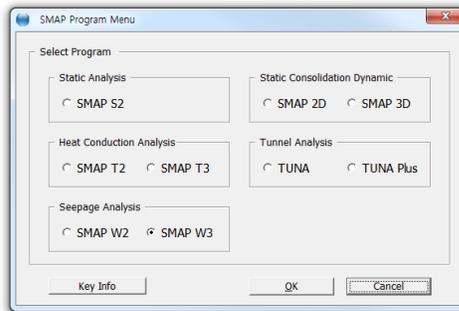
## Running Programs

### 3.1 Introduction

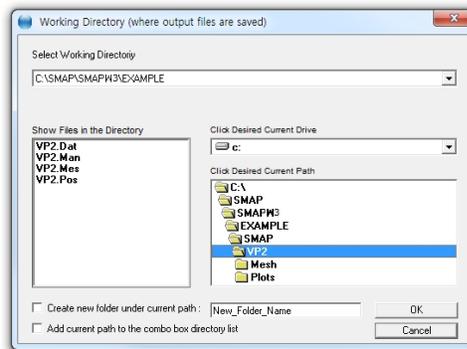
Generally, SMAP-W3 consists of pre-, main-, and post-processing programs. Pre-processing programs are mainly used to automatically generate Mesh Files which will contain nodal coordinates, boundary conditions, and element indexes. Main-processing program of SMAP-W3 is the one which computes water flow of three-dimensional problems. Post-processing programs are used to show graphically the results from the main-processing program.

### Accessing SMAP-W3 Programs

1. When it is the first time, you copy Smap.exe in C:\Ct\Ctmenu and setup a Shortcut to SMAP Icon on your computer desktop. Then You simply double-click SMAP Shortcut.
2. Select **SMAP-W3** radio button and then click **OK** button.



3. Next, you need to select **Working Directory**. Working Directory should be the existing directory where all the output files are saved. It is a good idea to have all your input files for the current project in this Working Directory. Click the disk drive, double-click the directory, and then **OK** button. Note that when you select **Working Directory**, a sub directory **Temp** is created automatically. All intermediate scratch files are saved in this sub directory **Temp**.



## SMAP-W3 Menu

**SMAP-W3** provides following Main Menus; Run, Plot, Setup, Exit, Text, Mesh and Wdir.

**RUN** executes main- and pre-processing programs and has following Sub Menus;

Smap,  
Mesh Generator,  
Load Generator,  
Swcc Analysis,  
PlotXY Generator,  
Command Line and  
Windows Explorer.

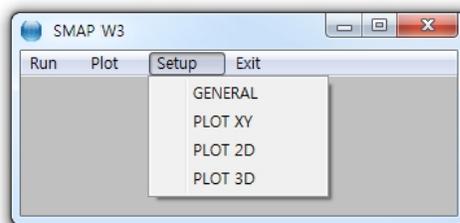
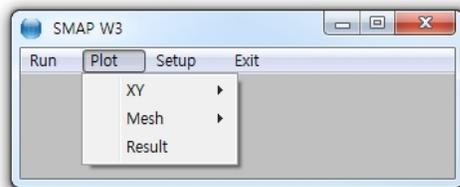
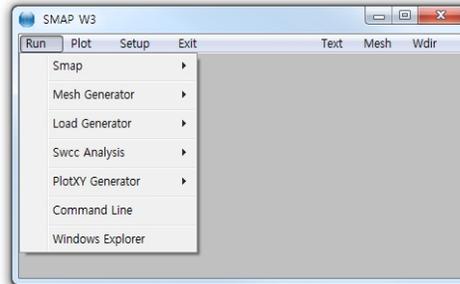
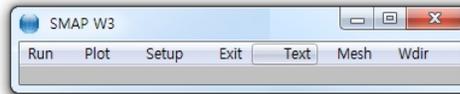
**PLOT** executes XY, Mesh, and Result. Result is associated with post-processing programs to show graphically the computed results.

**SETUP** is mainly used to set plotting control parameters for PLOT-XY, PLOT-2D, and PLOT-3D and has the following Sub Menus; General, PLOT-XY, PLOT-2D and PLOT-3D.

**EXIT** is used to end SMAP-W3.

**TEXT** is used to edit Text files. **MESH** is used to plot F. E. Mesh files.

**WDIR** is used to change Working Directory.

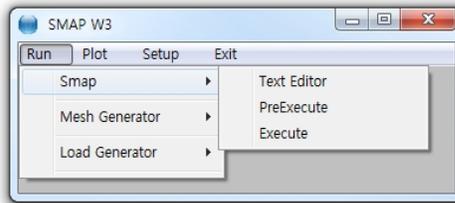


## 3.2 RUN Menu

### 3.2.1 SMAP

Once you have prepared the input files (Mesh, Main, and Post) according to the SMAP-W3 User's Manual in Section 4, you are ready to execute SMAP-W3 main-processing program.

**SMAP** Menu has the following Sub Menus; Text Editor, PreExecute, and Execute.



**TEXT EDITOR** is used to create or modify the input file using Notepad.

**PRE EXECUTE** is used either to check the input file or to generate plotting information files. **PRE EXECUTE** is especially useful when you want to check input data to see whether there is any input error. It is also useful when you have finished **EXECUTE** but you want to add or modify the Post File for plot. In this case, you edit the Post File as you want, run **PRE EXECUTE**, and then run post-processing programs in **PLOT** menu.

**EXECUTE** executes SMAP-W3 main-processing program.

### **SMAP-W3 Output Files**

Once you execute SMAP-W3, generally you can obtain following output files:

CONTSS.DAT	Contains water pressures in elements
DISPLT.DAT	Contains total head, pressure, and flow rates in nodes

It should be noted that all of your output files are saved in the Working Directory that you specified at the beginning.

### **SMAP-W3 Graphical Output**

SMAP-W3 Post-processing programs can generate the following graphical output:

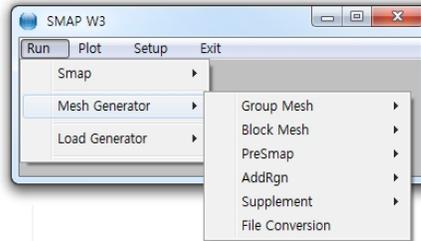
- Finite element mesh
- Contours of total head and water pressure
- Profiles of nodal flow velocity vectors
- Time histories of total head, water pressure and flow rate

Graphical output can be followed by running RESULT from PLOT Menu.

### 3.2.2 MESH GENERATOR

**MESH GENERATOR** is mainly used to model two and three dimensional finite element meshes that are used as Mesh File.

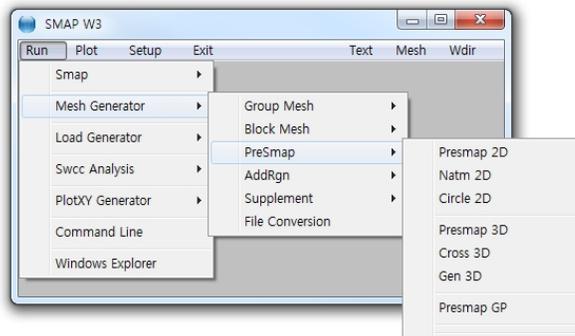
**MESH GENERATOR** Menu has the following Sub Menus; Group Mesh, Block Mesh, PreSmap, AddRgn, Supplement, and File Conversion.



**GROUP MESH** is a two-dimensional CAD program specially designed to build group mesh which can be used to generate finite element mesh with the aid of program ADDRGN-2D. Section 5 in SMAP-W3 Example Problems describes in detail about running Group Mesh.

**BLOCK MESH** is a three-dimensional CAD program specially designed to build block mesh which can be used to generate finite element mesh with the aid of program PRESMAP-GP. Section 6 in SMAP-W3 Example Problems describes in detail about running Block Mesh.

**PRESMAP** menu includes two and three dimensional pre-processing programs to generate finite element meshes: Section 7 in SMAP-W3 Example Problems describes in detail about running PRESMAP Programs.



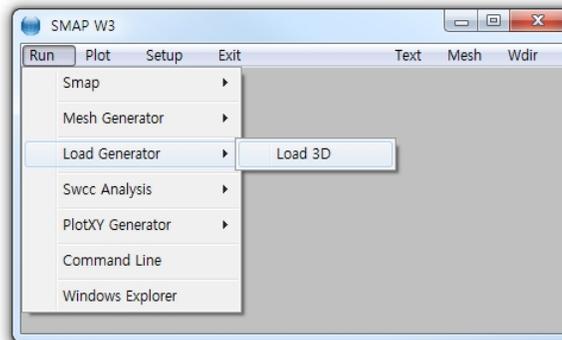
**ADDRGN** is the pre-processing program which has the following two basic functions: Combine two different meshes and modify existing meshes. Section 8 in SMAP-W3 Example Problems describes in detail about running ADDRGN programs.

**SUPPLEMENT** contains supporting programs which are useful to prepare input data for pre- and main-processing programs. Section 9 in SMAP-W3 Example Problems describes in detail about running SUPPLEMENT programs.

**FILE CONVERSION** is to convert Mesh File formats between different programs. IGES or FEMAP (Version 4.1- 4.5) can be converted to SMAP Mesh File format. Section 10 in SMAP-W3 User's Manual describes in detail about running FILE CONVERSION program.

### 3.2.3 LOAD GENERATOR

**LOAD GENERATOR** includes the pre-processing program **LOAD-3D** which can be used to generate initial head, specified total head, specified pressure head boundary, external water flow, and potential seepage face boundary. Section 10 in SMAP-W3 Example Problems describes in detail about running **LOAD-3D** program.



### 3.2.4 PlotXY GENERATOR

**PlotXY GENERATOR** is the graphical user interface which is mainly used to generate or edit [Simplified Time History](#) and [Simplified Snapshot](#) of Card Group 12 in [SMAP Post File](#). Section 12.7 in [SMAP-W3 User's Manual](#) describes in detail about running [PlotXY Generator](#) program.

### 3.2.5 COMMAND LINE

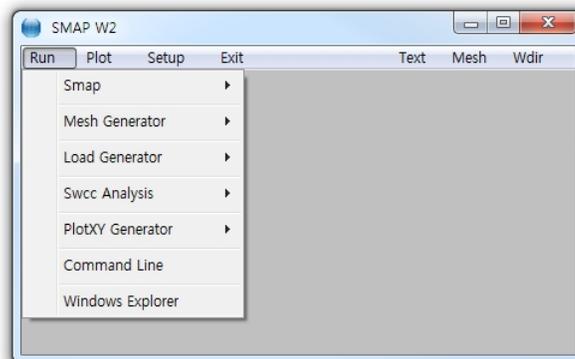
**COMMAND LINE** opens [Windows Command Prompt](#) at the current Working Directory. you can use a keyboard to navigate, access, and modify files and folders by entering commands. For example, **COMMAND LINE** is used when executing manually [SMAP](#) main solvers.

### 3.2.6 WINDOWS EXPLORER

**WINDOWS EXPLORER** opens [Windows File Explorer](#) at the current Working Directory. You can use a mouse to navigate and manage the drives, folders and files on your computer.

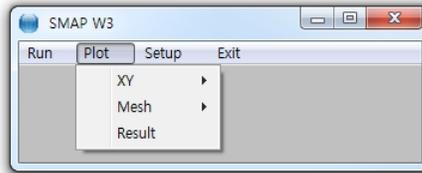
### 3.2.7 SWCC ANALYSIS

**SWCC ANALYSIS** opens the input file as prepared according to [SWCC User's Manual](#) and shows graphical outputs of specific moisture capacity, hydraulic conductivity, etc as a function of soil suction.



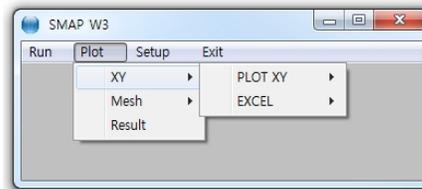
## 3.3 PLOT Menu

**PLOT Menu** is to show graphically XY graph, Mesh and Computed Result.



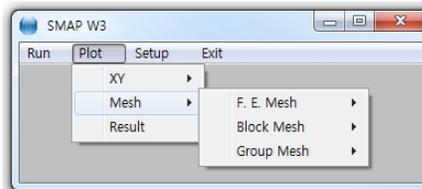
### 3.3.1 XY

**XY** graph can be displayed by PLOT-XY or EXCEL. Section 11 in SMAP-W3 Example Problems describes in detail about running XY graph.



### 3.3.2 MESH

**MESH** has following Sub Menus; F. E. Mesh, Block Mesh and Group Mesh.



**F. E. Mesh** is used to open or create Finite Element Mesh File.

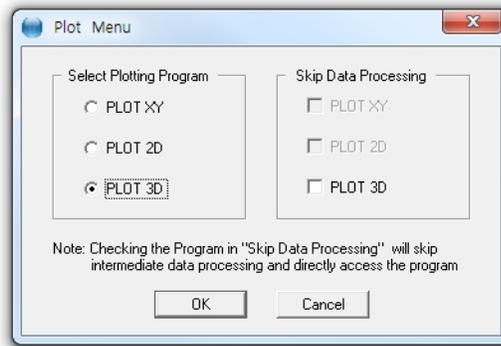
**Block Mesh** is used to open or build Block Mesh. Section 6 in SMAP-W3 Example Problems describes in detail about running Block Mesh.

**Group Mesh** is used to open or build Group Mesh. Section 5 in SMAP-W3 Example Problems describes in detail about running Group Mesh.

### 3.3.3 RESULT

Once you finished executing SMAP-W3 main-processing program, you need to run post-processing programs to show graphically numerical results.

**PLOT Menu** contains PLOT-XY, PLOT-2D, and PLOT-3D.



**PLOT-XY** reads Card 12 in Post File and plots time histories of computed results and snapshots of computed result vs. distance. Refer to PLOT-XY User's Manual in Section 13.

**PLOT-2D** reads Card 11 in Post File and plots contours of total head and water pressures. Refer to PLOT-2D User's Manual in Section 14.

**PLOT-3D** reads Mesh File and Smap Output Files and with no input for Post File, plots contours of total head, water pressure and iso surface. Refer to PLOT-3D User's Manual in Section 15.

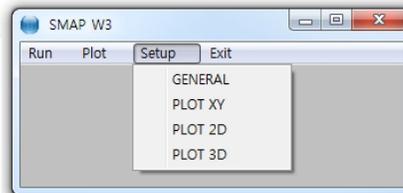
Note: When you first plot results, do not check the check box in Skip Data Processing. When you replot results, however, you can check the check box to skip intermediate data processing. This will save time and keep modified output data.

## 3.4 SETUP Menu

You need to run SETUP Menu

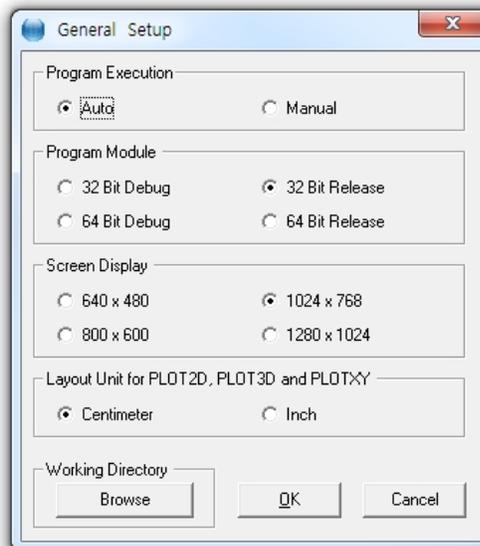
- To specify SMAP-W3 main-processing program module.
- To adjust scales of graphical outputs from PLOT-XY, PLOT-2D, and PLOT-3D

**SETUP Menu** has four Sub Menus; General, PLOT-XY, PLOT-2D, and PLOT-3D



### 3.4.1 General Setup

**General Setup** has five different items; Program Execution, Program Module, Screen Display, Layout Unit, and Working Directory.



**Program Execution** has two options; Auto and Manual. For Manual Execution, refer to Section 3.5 in User's Manual.

**Program Module** has four options. 32 Bit Debug, 32 Bit Release, 64 Bit Debug, and 64 Bit Release. Debug program modules run slower but gives more detailed information when run time errors occur. For most cases, 32 Bit Release is recommended. 64 Bit Modules are designed to run large problems.

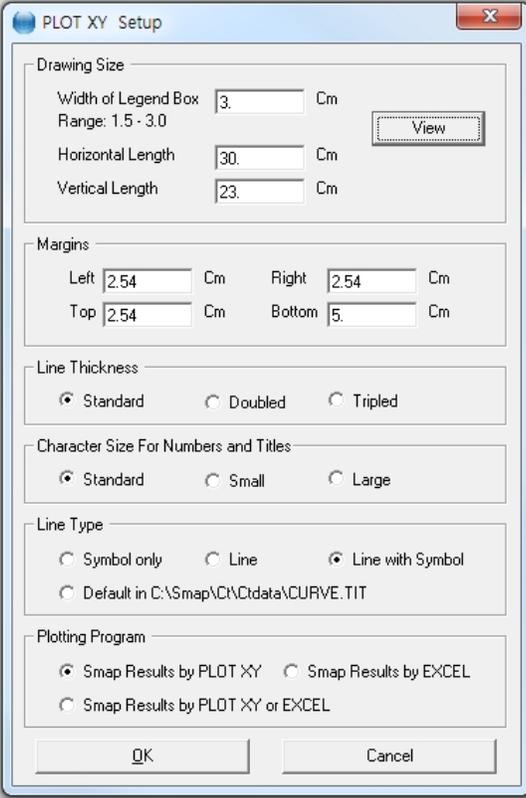
**Screen Display** has four options; 640x480, 800x600, 1024x768, and 1280x1024. This will affect the size of child window in PLOT-XY and PLOT-2D.

**Layout Unit** is used for PLOT-XY, PLOT-2D, and PLOT-3D. You can select either Centimeter or Inch in specifying plot scales and dimensions.

**Working Directory** is to change the current working directory. When you click the Browse button, Working Directory dialog will be shown so that you can select new directory.

### 3.4.2 PLOT-XY Setup

**PLOT-XY Setup** is mainly used to specify scales and dimensions of post processing program PLOT-XY. It has six different items; Drawing Size, Margins, Line Thickness, Character Size, Line Type, and Plotting Program.



The screenshot shows the 'PLOT XY Setup' dialog box with the following settings:

- Drawing Size:**
  - Width of Legend Box: 3.00 Cm (Range: 1.5 - 3.0)
  - Horizontal Length: 30.00 Cm
  - Vertical Length: 23.00 Cm
  - View button
- Margins:**
  - Left: 2.54 Cm
  - Right: 2.54 Cm
  - Top: 2.54 Cm
  - Bottom: 5.00 Cm
- Line Thickness:**
  - Standard
  - Doubled
  - Tripled
- Character Size For Numbers and Titles:**
  - Standard
  - Small
  - Large
- Line Type:**
  - Symbol only
  - Line
  - Line with Symbol
  - Default in C:\Smop\C\cdata\CURVE.TIT
- Plotting Program:**
  - Smop Results by PLOT XY
  - Smop Results by EXCEL
  - Smop Results by PLOT XY or EXCEL

Buttons: OK, Cancel

**Drawing Size** controls the size of output. Once you specify Legend Box Width, Horizontal and Vertical Length, you can click **View** button to see the scaled layout.

**Margins** is used to shift the drawing area. Left margin is the distance from the left edge of printer page to the left frame line. In the similar way, you can specify Top, Right, and Bottom margins.

**Line Thickness** specifies the thickness of lines. This option is not used.

**Character Size for Numbers and Titles** specifies the size of characters for numbers and titles. It has three options; Standard, Small, and Large.

**Line type** is used to specify default line type and has four options; Symbol only, Line, Line with Symbol, and Default in C:\ Smap\Ct\Ctdata\Curve.tit.

**Plotting Program** is used to specify default program to plot Smap results. It has three options; PLOT-XY, EXCEL, and PLOT-XY or EXCEL. Last option is to select either PLOT-XY or EXCEL at the time you plot results.

### 3.4.3 PLOT-2D Setup

**PLOT-2D Setup** is mainly used to specify scales and dimensions of post processing program PLOT-2D. It has six different items; Drawing Size, Margins, Line Thickness, Numeric Character Size, Scale and Block Option. The first four items are much similar to those described in PLOT-XY Setup.

**Scale** specifies Maximum Displacement Length, Maximum Principal Stress Length, Maximum Beam Section Force Length, and Maximum Truss Force/Stress Length, which will be shown on PLOT-2D.

**Block Option** specifies options to generate either PRESMAP Output or Block Diagram.

The screenshot shows the 'PLOT 2D Setup' dialog box with the following settings:

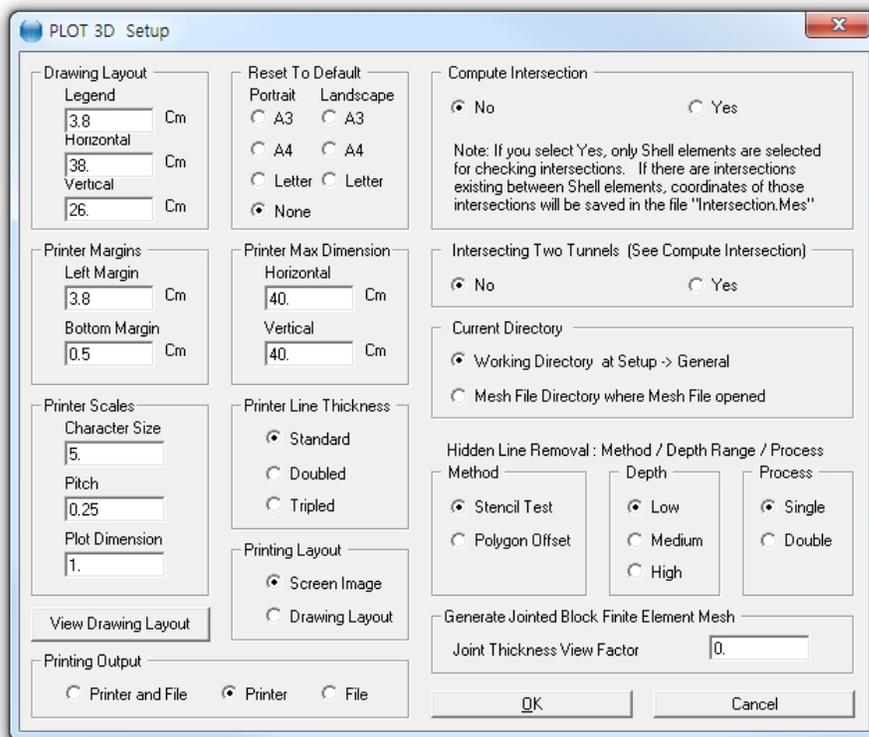
- Drawing Size:** Width of Legend Box: 6.0 Cm (Range: 3.0 - 6.0), Horizontal Length: 32.0 Cm, Vertical Length: 20.0 Cm. A 'View' button is present.
- Margins:** Left: 2.54 Cm, Right: 2.54 Cm, Top: 3.5 Cm, Bottom: 1.5 Cm.
- Line Thickness:**  Standard,  Doubled,  Tripled.
- Numeric Character Size:**  Standard,  Small,  Large.
- Scale:** Maximum Displacement Length: 1.4 Cm, Maximum Principal Stress Length: 1.04 Cm, Maximum Beam Section Force Length: 0.76 Cm, Maximum Truss Force/Stress Length: 0.38 Cm.

Buttons at the bottom: 'Block Option', 'OK', and 'Cancel'.

### 3.4.4 PLOT-3D Setup

**PLOT-3D Setup** is mainly used to specify scales and dimensions of post processing program PLOT-3D. In addition, it can compute intersection of shell elements and intersecting two tunnels for SMAP-3D. And It can also generate jointed block finite element meshes for SMAP-3D. It has thirteen different items; Drawing Layout, Printer Margins, Printer Scales, Reset To Default, Printer Max Dimension, Printer Line Thickness, Printing Layout, Printing Output, Compute Intersection, Intersecting Two Tunnels, Current Directory, Hidden Line Removal and Generate Jointed Block Finite Element Mesh.

Refer to descriptions shown in the PLOT-3D Setup dialog.



### 3.5 Manual Procedure to Run SMAP-W3

Occasionally, you need to execute SMAP-W3 main-processing program manually to see what is going on each step, specially when terminated due to some errors.

#### Method 1

1. Select Setup -> General -> Manual in Program Execution
2. Select Run -> Smap -> Execute
3. Select Smap project file when displaying file open dialog
4. Now Smap is running on Windows Command Line
5. Type **Enter key** to continue to next step or **Control C** to stop

#### Method 2

1. Select Run -> Command Line
2. Change to **Temp** sub directory  
Create **Temp** sub directory if not existing.  
Type **MD Temp**  
Then change to this sub directory.  
Type **CD Temp**  
Now, the files in the Working Directory can be accessed by prefixing **"..\\"** to the file name.
3. Type **C:\Smap\Ct\Ctbat\SmapW3**
4. Type **..\VP1.Dat** to access input file in Working Directory, for example
5. Type **Enter key** to continue to next step or **Control C** to stop

### **3.6 Debugging SMAP-W3 Main-Processing Program**

Debug information would be helpful in the following cases:

- Having run time errors
- Extracting convergence
- Checking elapsed time

In order to get debug information, you need to modify the file "Smap\_W3.dat" in the directory C:\Smap\Ct\Ctdata\Debug

```
1,      100
IDEBUG, ENDPASS

IDEBUG  =  0 : Do not print debug information.
          1 : Print general debug information.
          2 : Print detailed debug information.

ENDPASS      : Ending pass number.
              No printing debug information after ENDPASS.
```

Debug information is printed on the file Smap\_W3.deb in the Working Directory \Temp

This debug file allows listing of status with elapsed time information while running main process of SMAP programs. This is the very useful features to see where it spends most time and where it stops.

## **SMAP-W3 User's Manual**

### **4.1 Introduction**

To run SMAP-W3 main-processing program, you need to prepare a Project File which contains Mesh File name, Main File name and Post File name.

Mesh File contains nodal coordinates, boundary conditions, element indexes and material property numbers. This Mesh File is normally generated by Mesh Generator programs.

Main File contains all the other data required for the 3-dimensional numerical analysis of seepage problems.

Post File contains information which is used to show graphically the results from the main-processing program.

## 4.2 Project File

Project File is a collection of names of Mesh, Main and Post Files with the following text format:

```
Mesh File Name
  Full path of Mesh File
Main File Name
  Full path of Main File
Post File Name
  Full path of Post File
```

As an example, a Project File **VP2.Dat** can be written as:

```
Mesh File Name
  C:\Example\VP2.Mes
Main File Name
  C:\Example\VP2.Man
Post File Name
  C:\Example\VP2.Pos
```

### **4.3 Mesh File**

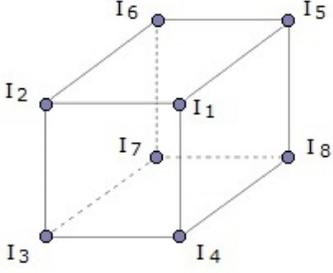
Mesh File contains nodal coordinates, boundary conditions, element indexes and material property numbers. This Mesh File is normally generated by Mesh Generator programs.

To plot Mesh File, select Mesh in Plot menu.

Mesh File

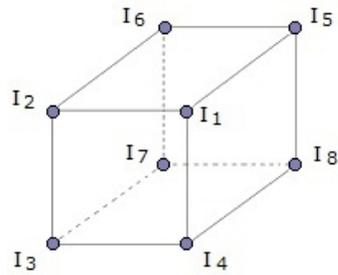
Card Group	Input Data and Definitions (Mesh File)
General Information	<p>1.1</p> <p>TITLE [Character string]</p> <p>TITLE      Project title</p>
	<p>1.2</p> <p>LABEL1 [Character string]</p> <p>LABEL1      Label for Card 1.3</p>
	<p>1.3</p> <p>NUMNP, NCONT, NBEAM, NTRUSS</p> <p>NUMNP      Total number of nodal points</p> <p>NCONT      Total number of continuum elements</p> <p>NBEAM      Total number of beam elements (N.A.)</p> <p>NTRUSS      Total number of truss elements (N.A.)</p>

Card Group	Input Data and Definitions (Mesh File)
Coordinate	<p>2.1</p> <p>LABEL2A [Character string]                      LABEL2B [Character string]</p> <p>LABEL2A      Label for coordinate                      LABEL2B      Label for Card 2.2</p>
	<p>2.2</p> <p>NUMNP      [    NODE, ID, IDF, X, Y, Z, H, CF                      Cards      [    -    -    -    -    -    -    -                      [    -    -    -    -    -    -    -</p> <p>NODE      Node number</p> <p>ID = 0      Specified external water flow                      = 1      Specified total head                      = 2      Specified pressure head                      = 3      Specified potential seepage face                      = 4      Same as ID = 3 but head based on hydrograph</p> <p>IDF      Identification number of time dependent function at Card 9.4. Absolute IDF is used.                      If ID = 1 and IDF &lt; 0,                      total head is specified based on hydrograph.                      Above water table, zero flux is specified.                      If ID &lt; 3 and IDF = 0, reset to ID = 0 and external water flow is zero at all times.                      If ID = 3, review potential seepage face and assign zero flow or zero pressure head                      If ID = 4, review potential seepage face and assign zero flow or total head based on hydrograph</p> <p>X, Y, Z      X, Y and Z coordinates, respectively.</p> <p>H      Initial total head</p> <p>CF      Coefficient of time dependent function for water flow or total/pressure head at the node.</p>

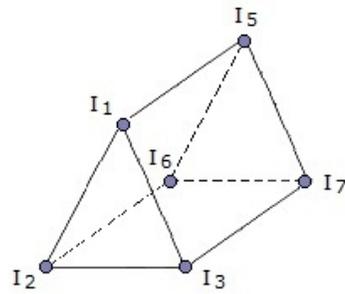
Card Group	Input Data and Definitions (Mesh File)
3	<div style="border-bottom: 1px solid black; padding-bottom: 10px;"> <p>3.1</p> <p>LABEL3A [Character string]                      LABEL3B [Character string]</p> <p style="margin-left: 40px;">LABEL3A      Label for coordinate                      LABEL3B      Label for Card 3.2</p> </div> <div style="padding-top: 10px;"> <p>3.2</p> <p>NCONT      [ NEL, I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub>, I<sub>5</sub>, I<sub>6</sub>, I<sub>7</sub>, I<sub>8</sub>, MATNO, IDH</p> <p>Cards      [ -   -   -   -   -   -   -   -   -   -   -</p> <p style="margin-left: 40px;">NEL          Element number</p> <p style="margin-left: 40px;">I<sub>1</sub> - I<sub>8</sub>      Element corner node numbers                      If I<sub>4</sub> = I<sub>8</sub> = 0, degenerates to wedge element</p> <p style="margin-left: 40px;">MATNO        Materia number</p> <p style="margin-left: 40px;">IDH          Time dependent function ID number for water generation rate (volume per time) at Card 9.4</p> <p style="margin-left: 40px; color: blue;">If IDH &lt; 0, absolute value of IDH refers to time history ID number for specified pressure head.</p> <div style="text-align: center; margin-top: 20px;">  </div> </div>

Element Surface No (NS)

NS	Index Number			
1	5	6	2	1
2	6	7	3	2
3	7	8	4	3
4	8	5	1	4
5	1	2	3	4
6	6	5	8	7



NS	Index Number			
1	5	6	2	1
2	6	7	3	2
3	7	5	1	3
5	1	2	3	0
6	6	5	7	0





## 4.4 Main File

**Mesh File** in the previous section 4.3 contains the geometrical data of the structure to be analyzed.

**Main File** contains all the other data required for the 3-dimensional numerical analysis of seepage problems.

Main File consists of seven different card groups:

- Title
- Analysis Parameters
- Computational Parameters
- Continuum Element
- Boundary Conditions
- Material Property Data
- Requested Output

Card Group	Input Data and Definitions (Main File)
1  Title	1.1  TITLE  TITLE      Title (Max 50 characters)
2  Analysis Parameters	2.1  IP, ILUMP, IBATCH, ISST, IMSEEP, IDFVEL, IFVOL, ISFACE  IP        = 0      Do not use temporary storage (N.A.) = 1      Use temporary storage for element data  ILUMP    = 0      Consistent capacity matrix = 1      Lumped capacity matrix  IBATCH   = 0      Interactive terminal job = -1     Same as IBATCH = 0 with short beep sound when calculation is finished  ISST      = 0      Steady-state solution = 1      Transient solution  IMSEEP   = 0      General seepage face review = 1      Bottom up seepage face review (N.A.)  Darcy nodal flow vector IDFVEL   = 0      Galerkin residual method = 1      Averaging element corner vector  IFVOL     = 0      Nodal flow volume by global equation = 1      Nodal flow volume by element equation  ISFACE   = 0      Initial seepage face specified by flux = 1      Initial seepage face specified by head



Card Group	Input Data and Definitions (Main File)	
Computational Parameters	3	<p>3.2</p> <p><b>Solution Iteration Parameter</b></p> <p>SIP</p> <p>SIM = 0.5 Under relaxation Recommend when solution is fluctuating</p> <p>= 1.0 Exact relaxation</p> <p>= 2.0 Over relaxation</p>
		<p>3.2.1</p> <p>IDELT, DT</p> <p>IDELT = 0 Constant time step (DT)</p> <p>= 1 Every step uses new step at Card 3.2.2</p> <p>= -1 Every 100 steps use new step at Card 3.2.2</p> <p>DT Constant time step for IDELT = 0</p>
	Time Steps	<p>3.2.2</p> <p>If IDELT = 0, go to Card Group 3.3</p> <p>NUMDT</p> <p>DT<sub>1</sub> DT<sub>2</sub> DT<sub>3</sub> ---- DT<sub>NUMDT</sub></p> <p>NUMDT Number of specified time steps</p> <p>DT<sub>i</sub> Specified time step</p>









Card Group	Input Data and Definitions (Main File)																			
9	9.4	<p>9.4.1</p> <p>NTIMF, NTIM, ITIMF</p> <p>NTIMF      Number of time functions (Max=25)</p> <p>NTIM        Number of time points (Max=11000)</p> <p>ITIMF = 0   Time functions (Card 9.4.2) from Main File                     = 1   Time functions from TimeFunction.dat                         First 3 lines represent headers</p> <p>If NTIM = 0, go to Card group 9.5</p>																		
		<p>9.4.2</p> <table border="0"> <tr> <td>TIME<sub>1</sub></td> <td>FN<sub>1,1</sub></td> <td>FN<sub>2,1</sub></td> <td>---</td> <td>FN<sub>NTIMF,1</sub></td> </tr> <tr> <td>TIME<sub>2</sub></td> <td>FN<sub>1,2</sub></td> <td>FN<sub>2,2</sub></td> <td>---</td> <td>FN<sub>NTIMF,2</sub></td> </tr> <tr> <td>-</td> <td>-</td> <td>-</td> <td>---</td> <td>-</td> </tr> <tr> <td>TIME<sub>NTIM</sub></td> <td>FN<sub>1,NTIM</sub></td> <td>FN<sub>2,NTIM</sub></td> <td>---</td> <td>FN<sub>NTIMF,NTIM</sub></td> </tr> </table> <p>TIME<sub>i</sub>    Specified time</p> <p>FN<sub>i,j</sub>    Value of function i at specified time j</p>	TIME <sub>1</sub>	FN <sub>1,1</sub>	FN <sub>2,1</sub>	---	FN <sub>NTIMF,1</sub>	TIME <sub>2</sub>	FN <sub>1,2</sub>	FN <sub>2,2</sub>	---	FN <sub>NTIMF,2</sub>	-	-	-	---	-	TIME <sub>NTIM</sub>	FN <sub>1,NTIM</sub>	FN <sub>2,NTIM</sub>
TIME <sub>1</sub>	FN <sub>1,1</sub>	FN <sub>2,1</sub>	---	FN <sub>NTIMF,1</sub>																
TIME <sub>2</sub>	FN <sub>1,2</sub>	FN <sub>2,2</sub>	---	FN <sub>NTIMF,2</sub>																
-	-	-	---	-																
TIME <sub>NTIM</sub>	FN <sub>1,NTIM</sub>	FN <sub>2,NTIM</sub>	---	FN <sub>NTIMF,NTIM</sub>																

Boundary Conditions

Time Dependent Function Specifications

Card Group	Input Data and Definitions (Main File)											
9	9.5	<p>9.5.1</p> <p>NWPRF, NWPR, IWPF, INTP</p> <p>NWPRF    Number of pressure functions (Max = 25)</p> <p>NWPR      Number of pressure points (Max=11000)</p> <p>IWPF = 0    Pressure functions (Card 9.5.2) from Main File</p> <p>          = 1    Pressure functions from PresFunction.dat                   First 7 lines represent headers</p> <p>          = 2    Same as IWPF = 1 but specific moisture is                   computed from volumetric water content</p> <p>                  Interpolations between WPRS and (K, MV)</p> <p>INTP = 0    Linear scales</p> <p>          = 1    Semi-logarithmic scales (Arithmetic WPRS)</p> <p>          = 2    Logarithmic scales</p> <p>If NWPRF = 0 or IWPF &gt; 0 , go to Card group 10</p>										
		<p>9.5.2</p> <table border="0"> <tr> <td>WPRS<sub>1</sub></td> <td>K<sub>1,1</sub> K<sub>2,1</sub> -</td> <td>MV<sub>1,1</sub> MV<sub>2,1</sub> -</td> </tr> <tr> <td>WPRS<sub>2</sub></td> <td>K<sub>1,2</sub> K<sub>2,2</sub> -</td> <td>MV<sub>1,2</sub> MV<sub>2,2</sub> -</td> </tr> <tr> <td>WPRS<sub>NWPR</sub></td> <td>K<sub>1, NWPR</sub> K<sub>2, NWPR</sub> -</td> <td>MV<sub>1, NWPR</sub> MV<sub>2, NWPR</sub> -</td> </tr> <tr> <td></td> <td>K<sub>NWPRF, NWPR</sub></td> <td>MV<sub>NWPRF, NWPR</sub></td> </tr> </table> <p>WPRS<sub>i</sub>    Specified water pressure (suction as positive)</p> <p>K<sub>i,j</sub>      Permeability at water pressure WPRS<sub>j</sub></p> <p>MV<sub>i,j</sub>    Specific moisture (MW)    at WPRS<sub>j</sub> for IWPF = 1                   Volumetric water content at WPRS<sub>j</sub> for IWPF = 2</p>	WPRS <sub>1</sub>	K <sub>1,1</sub> K <sub>2,1</sub> -	MV <sub>1,1</sub> MV <sub>2,1</sub> -	WPRS <sub>2</sub>	K <sub>1,2</sub> K <sub>2,2</sub> -	MV <sub>1,2</sub> MV <sub>2,2</sub> -	WPRS <sub>NWPR</sub>	K <sub>1, NWPR</sub> K <sub>2, NWPR</sub> -	MV <sub>1, NWPR</sub> MV <sub>2, NWPR</sub> -	
WPRS <sub>1</sub>	K <sub>1,1</sub> K <sub>2,1</sub> -	MV <sub>1,1</sub> MV <sub>2,1</sub> -										
WPRS <sub>2</sub>	K <sub>1,2</sub> K <sub>2,2</sub> -	MV <sub>1,2</sub> MV <sub>2,2</sub> -										
WPRS <sub>NWPR</sub>	K <sub>1, NWPR</sub> K <sub>2, NWPR</sub> -	MV <sub>1, NWPR</sub> MV <sub>2, NWPR</sub> -										
	K <sub>NWPRF, NWPR</sub>	MV <sub>NWPRF, NWPR</sub>										

Card	Input Data and Definitions (Main File)
Requested Output	<p>10.1</p> <p><b>NTPRNT</b></p> <p>NTPRNT    Number of cycles between output data print</p>
	<p>10.2.1</p> <p><b>NHPEL</b></p> <p>NHPEL    Number of elements at which water pressure time histories are requested</p>
	<p>10.2.2</p> <p>If NHPEL = 0, skip the following Card</p> <p>NEL<sub>1</sub> NEL<sub>2</sub> ... NEL<sub>NHPEL</sub></p> <p>NEL    Element number to be printed</p>
	<p>10.3.1</p> <p><b>NHPMT</b></p> <p>NHPMT    Number of nodes at which total head / pressure time histories are requested</p>
	<p>10.3.2</p> <p>If NHPMT = 0, skip the following Card</p> <p>NODE<sub>1</sub> NODE<sub>2</sub> ... NODE<sub>NHPMT</sub></p> <p>NODE    Node number to be printed</p>
	<p>10.4.1</p> <p><b>NTIME</b></p> <p>NTIME    Number of times at which total head / pressure profiles are requested</p>
	<p>10.4.2</p> <p>If NTIME = 0, skip the following Card</p> <p>TIME<sub>1</sub> TIME<sub>2</sub> ... TIME<sub>NTIME</sub></p> <p>TIME    Time to be printed</p>

Card	Input Data and Definitions (Main File)
Requested PLOT-XY Output File: FLOW.Lin	<p>10.5.1</p> <p>NPHD, ZEFS</p> <p>NPHD      Number of water pressure lines</p> <p>ZEFS      Z coordinate of element front surface</p> <p>            Apply to Card groups 10.5, 10.6, and 10.7</p>
	<p>10.5.2</p> <p>If NPHD = 0, skip the following Card</p> <p>WP<sub>1</sub> WP<sub>2</sub> ... WP<sub>NPHD</sub></p> <p>WP      Water pressure to be plotted</p>
	<p>10.6.1</p> <p>NTHD</p> <p>NTHD      Number of equipotential lines</p> <p>            For NTHD &lt; 0, PLOT-XY plots without legends</p>
	<p>10.6.2</p> <p>If NTHD = 0, skip the following Card</p> <p>TH<sub>1</sub> TH<sub>2</sub> ... TH<sub>NTHD</sub></p> <p>TH      Total heads to be plotted</p>
	<p>10.7.1</p> <p>NFLN    ISPL    DELV</p> <p>NFLN      Number of flow lines</p> <p>            For NFLN &lt; 0, PLOT-XY plots without legends</p> <p>ISPL      Split quad. element into triangles (0: No, 1: Yes)</p> <p>DELV      Vector length to trace flow path</p> <p>            Default: one half of smallest element length</p>
	<p>10.7.2</p> <p>If NFLN = 0, skip the following Card</p> <p>NOD<sub>1</sub> NOD<sub>2</sub> ... NOD<sub>NFLN</sub></p> <p>NOD      Node numbers from which flow line start</p>



## 4.5 Post File

Post File contains information which are used to show graphically the results from the main-processing program.

Post File consists of three different card groups:

- Card Group 11 (PLOT-2D)
- Card Group 12 (PLOT-XY)
- Card Group 13 (FEMAP )

Card Group 11 contains the input data which are used to plot the following snapshots in two dimension:

- Finite element mesh / element / node number
- Total head / water pressure distribution

Card Group 12 contains the input data for following plots:

Time history

- Total head / water pressure

Snapshot

- Total head / water pressure vs. distance

Card Groups 13 is no longer supported.

These plots can be performed automatically by using PLOT-3D.

PLOT-2D  
Post-Processor







PLOT-XY  
Post-Processor





















Card Group	Input Data and Definitions (Post File)	
PLOT-XY Information	12.5 For IPTYPE = 4 (Nodal Total Head / Pressure vs Distance)	12.5.6 ISCALD, ILTNUM, XSTART  ISCALD = 0    Unscaled distance = 1    Scaled distance  ILTNUM = 0    Do not list node numbers = 1    List Node No vs Value in PlotXy.Lin  XSTART        Reference starting X-coordinate  Note: If ISCALD = 1 and ILTNUM = 1, X-LABEL is used for distance unit











Card Group	Input Data and Definitions										
12       PLOT-XY Information       For IPTYPE = 9 (Snap Shot of Water Pressure for a Given Time)	12.10.1	TIME TIME Specified time									
	12.10.2	NDQ NDQ Number of different quantities Use NDQ = 1									
	12.10.3	<table border="0"> <tr> <td>NDQ</td> <td rowspan="2"> <math>\left[ \begin{array}{l} K_{y1} \\ K_{y2} \end{array} \right.</math> </td> <td></td> </tr> <tr> <td>Cards</td> <td>-</td> <td></td> </tr> <tr> <td><math>K_y</math></td> <td></td> <td>Use <math>K_y = 51</math></td> </tr> </table>	NDQ	$\left[ \begin{array}{l} K_{y1} \\ K_{y2} \end{array} \right.$		Cards	-		$K_y$		Use $K_y = 51$
	NDQ	$\left[ \begin{array}{l} K_{y1} \\ K_{y2} \end{array} \right.$									
	Cards		-								
	$K_y$		Use $K_y = 51$								
	12.10.4	XSTART XSTART Reference starting X-coordinate									
12.10.5	<u>Element Number Specification (Max 800 Elements)</u> NRL $N_1, N_2, N_{NRL}$ NRL Number of elements $N_1, N_2, \dots, N_{NRL}$ Element numbers $N_i, -N_{i+1}, N_{i+2}$ From $N_i$ to $N_{i+1}$ with increment $N_{i+2}$										
12.10.6	TPFAC, SDFAC <table border="0"> <tr> <td></td> <td>Multiplication factor</td> </tr> <tr> <td>TPFAC</td> <td>Water pressure</td> </tr> <tr> <td>SDFAC</td> <td>Distance</td> </tr> </table>		Multiplication factor	TPFAC	Water pressure	SDFAC	Distance				
	Multiplication factor										
TPFAC	Water pressure										
SDFAC	Distance										
12.10.7	TITLE (50 characters) X - LABEL (50 characters) Y - LABEL (50 characters)										



Card Group	Input Data and Definitions	
12	PLOT-XY Information  For IPTYPE = 11 (Snap Shot of Total Head / Pressure for a Given Time)	12.12.1 <b>TIME</b> TIME    Specified time
12.12.2 <b>NDQ</b> NDQ    Number of different quantities Use NDQ = 1		
12.12.3 NDQ $\begin{cases} \lceil & K_{y1} \\ \lfloor & \end{cases}$ Cards $\begin{cases} \lceil & \\ \lfloor & \end{cases}$  K <sub>y</sub> = 41: Total head    42: Water pressure 43: Flow rate    44: Flow velocity		
12.12.4 <b>XSTART</b> XSTART    Reference starting X-coordinate		
12.12.5 <u>Node Number Specification (Max 800 Nodes)</u> <b>NRL</b> N <sub>1</sub> , N <sub>2</sub> , N <sub>NRL</sub> NRL    Number of nodes N <sub>1</sub> , N <sub>2</sub> , ..., N <sub>NRL</sub> Node numbers N <sub>i</sub> , -N <sub>i+1</sub> , N <sub>i+2</sub> From N <sub>i</sub> to N <sub>i+1</sub> with increment N <sub>i+2</sub>		
12.12.6 <b>TPFAC, SDFAC</b>  TPFAC    Multiplication factor Total head / Water pressure / K <sub>y</sub> = 43 ~ 44 SDFAC    Distance		
12.12.7 TITLE    (50 characters) X - LABEL (50 characters) Y - LABEL (50 characters)		

Card Group	Input Data and Definitions	
12       PLOT-XY Information       For IPTYPE = 12 (Snap Shot of Total Head / Pressure for Different Times)	12.13.1	NOTM NOTM    Number of times (Max 10)
	12.13.2	TLIST (I), I = 1, NOTM TLIST (I)    List times in sequential order
	12.13.3	K <sub>y</sub> K <sub>y</sub> = 41: Total head    42: Water pressure 43: Flow rate      44: Flow velocity
	12.13.4	XSTART XSTART    Reference starting X-coordinate
	12.13.5	<u>Node Number Specification (Max 800 Nodes)</u> NRL N <sub>1</sub> , N <sub>2</sub> , N <sub>NRL</sub>  NRL                            Number of nodes N <sub>1</sub> , N <sub>2</sub> , ..., N <sub>NRL</sub> Node numbers N <sub>i</sub> , -N <sub>i+1</sub> , N <sub>i+2</sub> From N <sub>i</sub> to N <sub>i+1</sub> with increment N <sub>i+2</sub>
	12.13.6	TPFAC, SDFAC  Multiplication factor TPFAC            Total head / Water pressure / K <sub>y</sub> = 43 ~ 44 SDFAC            Distance
	12.13.7	TITLE        (50 characters) X - LABEL    (50 characters) Y - LABEL    (50 characters)



## Group Mesh User's Manual

### 5.1 Introduction

[Group Mesh Generator](#) is a two-dimensional CAD program specially designed to build group mesh which can be used to generate finite element mesh with the aid of program [ADDRGN-2D](#).

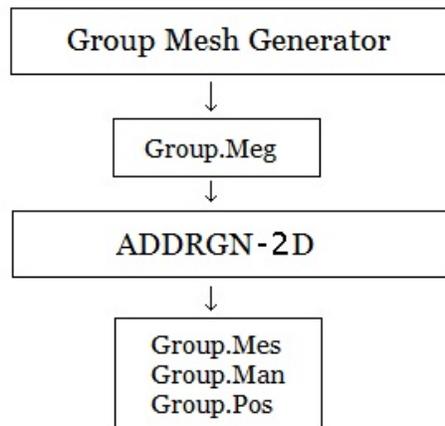


Figure 5.1 Flow diagram of group mesh generation

**Group.Meg** contains group mesh data that can be generated or modified by [Group Mesh Generator](#). The file **Group.Meg** is used as input to the program [ADDRGN-2D](#), thereby generating finite element mesh file **Group.Mes** along with the main file **Group.Man** for element activity and the post file **Group.Pos** for [PLOT-2D](#) plot.

**Group Mesh Generator** can be accessed through **SMAP** menu **Run** or **Plot** as explained in Section 5.2.

**ADDRGN-2D** can be accessed from **SMAP** menu:  
**Run** → **Mesh Generator** → **AddRgn** → **Addrgn 2D**.

This program can also be accessed indirectly by executing **F. E. Mesh Plot** in **Group** dialog as explained in Section 5.3.8.

## **5.2 Group Mesh Generator**

**Group Mesh Generator** can be accessed by selecting the following menu items in **SMAP**:

**Run** → **Mesh Generator** → **Group Mesh** or  
**Plot** → **Mesh** → **Group Mesh**

When you build new group mesh, you can select either **Built-in Base Mesh** or **Existing Finite Element Mesh**. **Built-in Base Mesh** is explained in detail in Section 5.4.

Once you click **OK** button in **Group Input** dialog, **PLOT-2D** program is displayed along with group menu which is the main access to **Group Mesh Generator**.

When click **Group** menu in **PLOT-2D**, **Group** dialog is displayed.

## **5.3 Group**

**Group** dialog in Figure 5.2 is the main dialog associated with group mesh generation or modification. **Group** dialog consists of following eight parts:

- Group Identity
- MTYPE and Material Parameter
- Line Options
- Coordinate Constraint
- Element Activity
- PLOT-2D Plot
- Translation
- Command Buttons

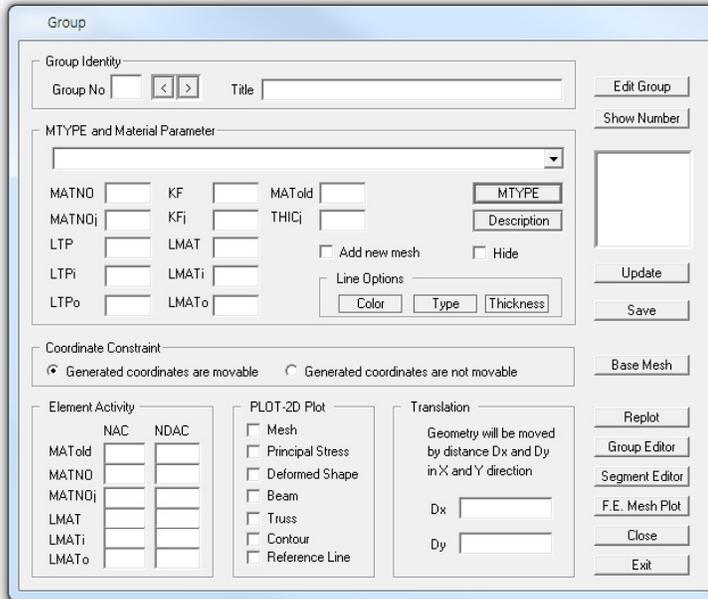


Figure 5.2 Group dialog.

### 5.3.1 Group Identity

Here, you type **Group No** and **Title**.

When you add a new group, first select an appropriate **MType** and change all default parameters as you want. Then click **Add Group** button to build the geometry of new group.

When you type the existing **Group No**, all parameters of that group are shown on the screen. Click **Edit Group** button to modify the geometry of the group.

It should be noted that **Add Group** and **Edit Group** buttons share the same position in the **Group** dialog. And **Add Group** for new group and **Edit Group** for existing group will appear.

### 5.3.2 MTYPE and Material Parameter

MTYPE dialog with icons and MTYPE list box with brief explanations are shown in Figures 5.3 and 5.4, respectively.

You can select MTYPE from the list box or by clicking MTYPE button which opens MTYPE dialog with icons.

Selection of proper MTYPE is the most important to model the desired group. Once you select MTYPE, all input variables and options available for that MTYPE will be shown on the screen along with default values.

Figure 5.3  
MTYPE dialog

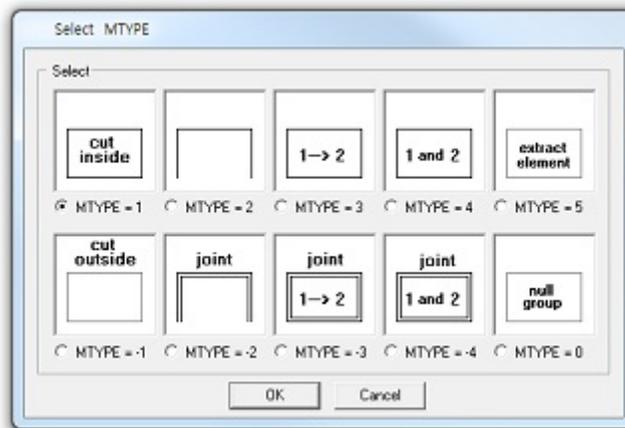
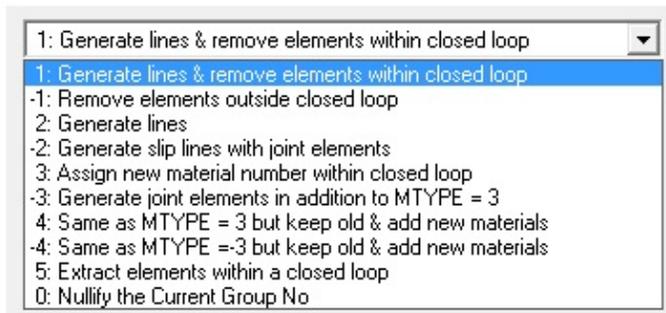


Figure 5.4  
MTYPE list box



Click [Description](#) button to see description of material parameters and element activity as shown in Figure 5.5.

[Add new mesh](#) check box is available only for [MTYPE](#) = 3. When checked, new group is formed without interfering with the other groups.

[Hide](#) check box is to hide the current group geometry on the screen when checked.

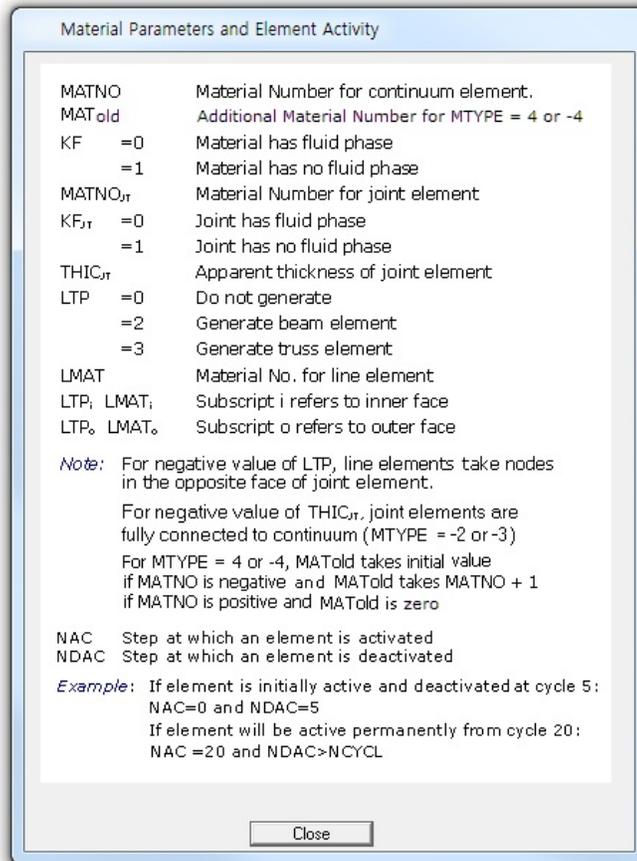


Figure 5.5 Material parameters & element activity ([SMAP-2D](#))

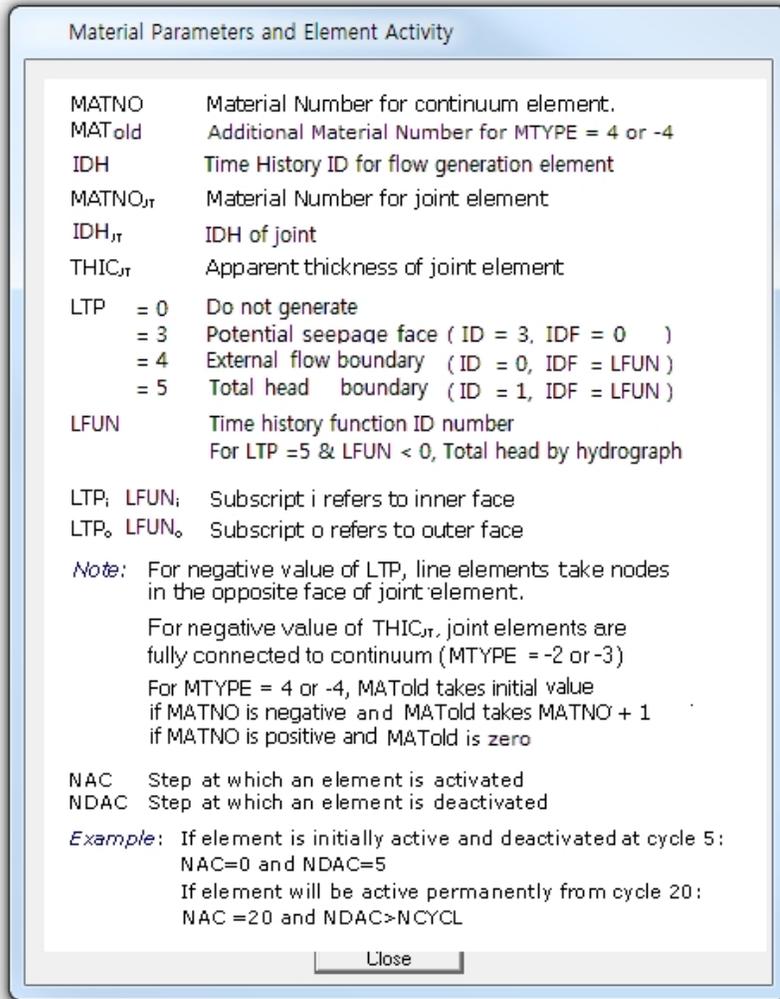


Figure 5.5 Material parameters & element activity ([SMAP-W2](#))

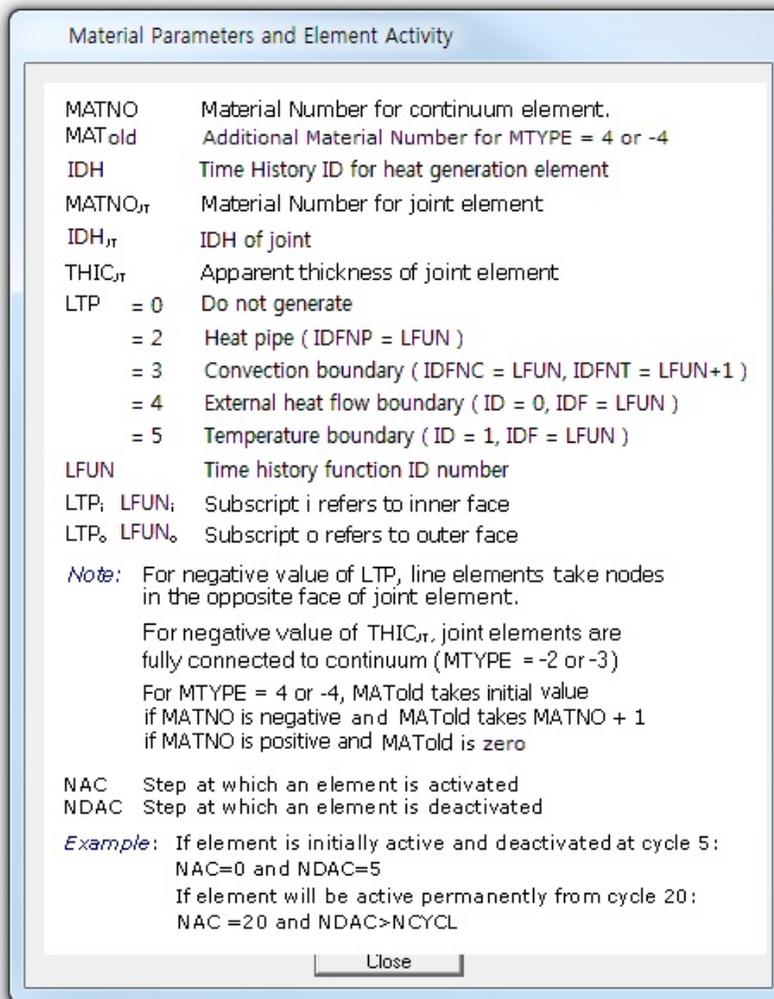


Figure 5.5 Material parameters &amp; element activity (SMAP-T2)

### 5.3.3 Line Options

Line options are provided to distinguish the outline of the group from the other groups. Figure 5.6 shows available line color, line type and line thickness.

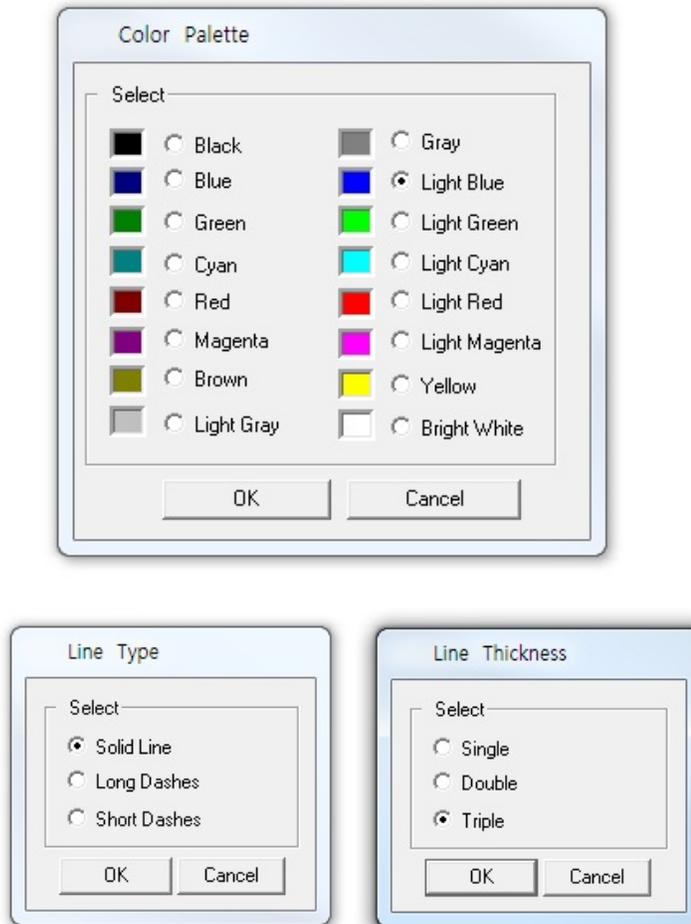


Figure 5.6 Line options.

### 5.3.4 Coordinate Constraint

Finite element meshes are generated when you click [F. E. Mesh Plot](#) button.

Normally, finite element nodal coordinates associated with the current group are adjusted to get the overall optimum meshes by selecting [Generated coordinates are movable](#).

However, you can make such generated coordinates not movable by selecting [Generated coordinates are not movable](#).

### 5.3.5 Element Activity

[Element activity](#) data is used in [SMAP](#) main program Card group 8. Elements in current group is to activate at step [NAC](#) and deactivate at step [NDAC](#). Such activity data is generated and saved in Group.Man when executing group mesh, that is, by clicking [F. E. Mesh Plot](#) button.

Examples of element activity are shown at bottom of Fig. 5.5.

### 5.3.6 PLOT-2D Plot

[PLOT-2D](#) Plot data is used in [SMAP](#) post processing program [PLOT-2D](#) to plot computed results available for the current group. Such plot information is generated and saved in Group.Pos when executing group mesh.

It should be noted that [SMAP](#) post processing program [PLOT-3D](#) can automatically produce all such plots.

### 5.3.7 Translation

[Translation](#) is mainly used to move the geometry of the current group in x and y directions. Here  $D_x$  and  $D_y$  represent relative distances from the current position of the group to the new position.

Once you type in  $D_x$  and  $D_y$ , you need to click [Update](#) and then [Replot](#) buttons to confirm the translation of the current group.

### 5.3.8 Command Buttons

[Command buttons](#) are shown on the right side of [Group](#) dialog.

#### [Add Group](#)

This is used to build the geometry of the new group.

[Line Segment](#) dialog in Figure 5.14 will be displayed.

#### [Edit Group](#)

This is used to modify the geometry of the existing group.

[Edit Segment](#) dialog in Figure 5.7 will be displayed.

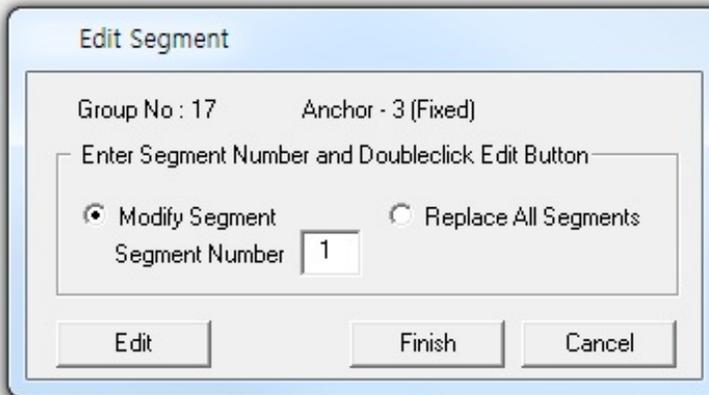


Figure 5.7 Edit segment dialog.

### [Show Number](#)

This is used to show group and segment numbers.

[Plot Group / Segment No](#) dialog in Figure 5.8 will be displayed.

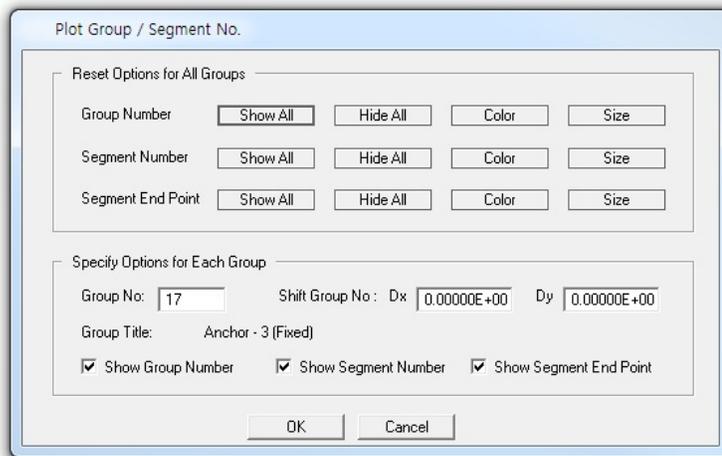


Figure 5.8 Plot Group / Segment No dialog.

### [Update](#)

This is used to update the current group parameters shown on the screen. It should be noted that you need to click [Update](#) button before leaving the current group. Leaving the current group without clicking [Update](#) will not update all the changes you made on the current group.

### [Save](#)

This is used to save all the works you have done . This includes updating the current group parameters shown in the [Group](#) dialog.

### [Base Mesh](#)

This is used to edit [Built-in Base Mesh](#) which is explained in detail in Section 5.4. [Base Mesh](#) dialog in Figure 5.13 will be displayed.

[Replot](#)

This is used to show the geometry of groups you have updated so far.

[Group Editor](#)

This is used to delete, cut and paste, or copy and paste specified groups.

[Group Editor](#) dialog in Figure 5.9 will be displayed.

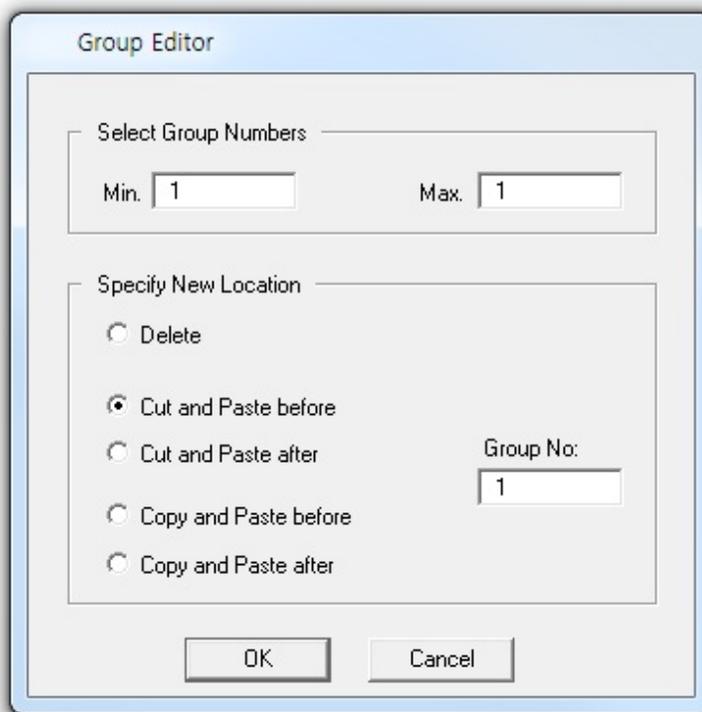


Figure 5.9 Group editor dialog.



[Close](#)

This is used to close the [Group](#) dialog.

[Exit](#)

This is used to exit from the [Group Mesh Generator](#).

[Exit](#) dialog in Figure 5.11 will be displayed.

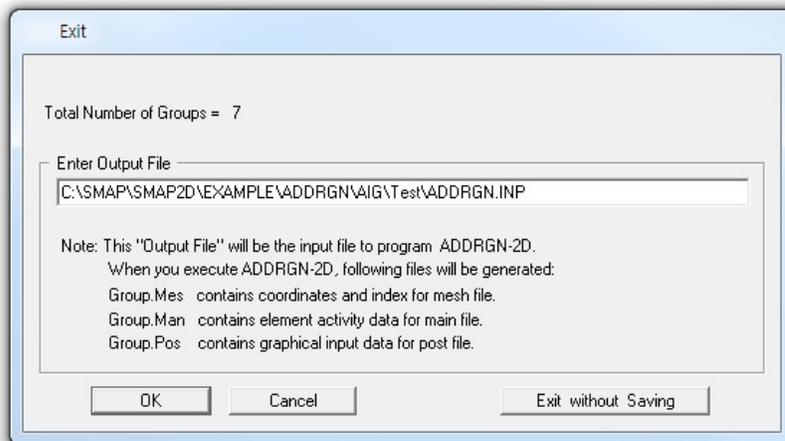


Figure 5.11 Exit dialog.

## 5.4 Base Mesh

**Base Mesh** is the finite element mesh where you build group meshes. You can select either **Built-in Base Mesh** or **Existing Finite Element Mesh** at the time when you first build new group mesh as discussed in Section 5.2.

### 5.4.1 Built-in Base Mesh

Figure 5.12 shows layout of **Built-in Base Mesh** which consists of rectangular blocks that will be filled with finite elements.

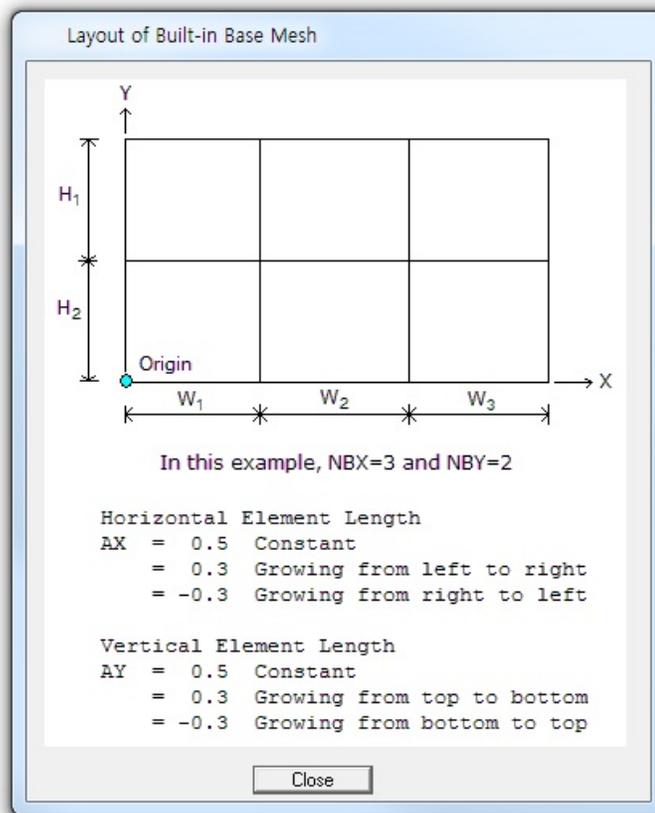


Figure 5.12 Layout of built-in base mesh.

Figure 5.13 shows **Built-in Base Mesh** dialog which is used to edit block dimensions, element sizes and boundary conditions.

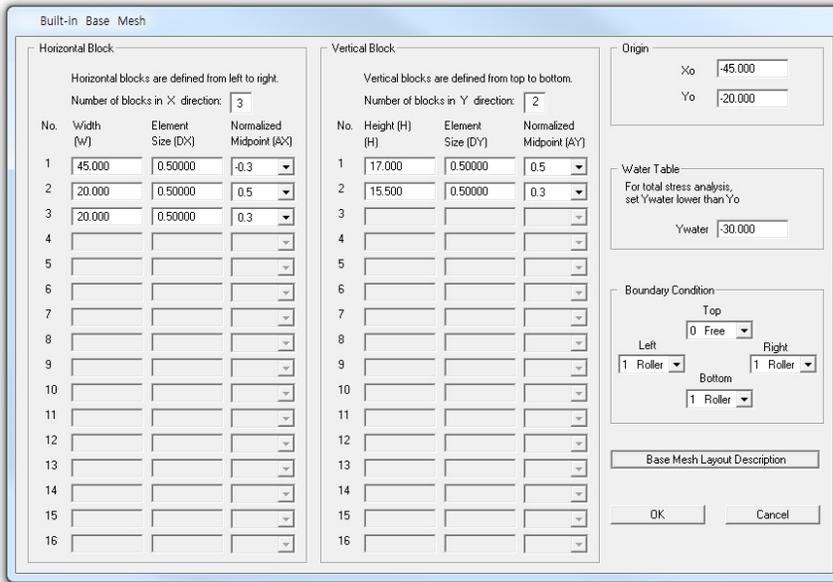


Figure 5.13 Built-in base mesh dialog.

### 5.4.2 Existing Finite Element Mesh

You can provide existing finite element mesh file to be used as base mesh. Group meshes will be built on this finite element mesh.

## 5.5 Segment

There are two types of segments, [Line](#) and [Arc Segments](#) which are used to build a group. [Segment](#) dialog will be displayed when you click [Add Group](#) or [Edit Group](#) button on the [Group](#) dialog screen.

### 5.5.1 Line Segment

Figure 5.14  
Line segment dialog.

Line Segment

Segment No : 1

Group No : 1 Group No = 1

Points By

Mouse Pickup  Enter X and Y

Beginning Point

X =

Y =

Ending Point

X =

Y =

Divisions and Inclusions

Number of divisions:

2: Include beginning & ending point

Draw Arc Segment Undo Finish Cancel

[Line Segment](#) dialog is shown in Figure 5.14.

#### [Segment No](#)

Current segment number will be displayed automatically.

#### [Group No & Title](#)

Current group number and title will be displayed automatically.

#### [Point By](#)

Select [Mouse Pickup](#) or [Enter X and Y](#).

Beginning & Ending Point

Coordinates of beginning and ending points are required when **Enter X and Y** is selected.

Divisions and Inclusions

Use following default values.

Number of divisions    **0**

Combo box selection    **2: Include beginning & ending point**

Draw

Draw line segment.

For **Mouse Pickup**,

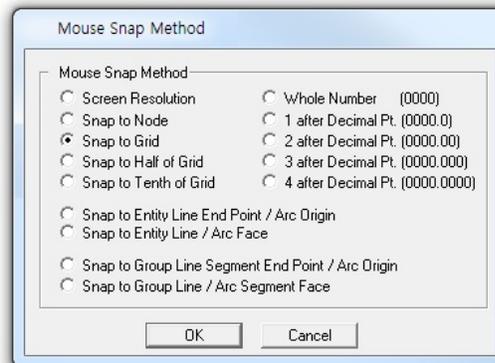
1. Click **Draw** button.
2. Move the mouse to the point and click left mouse button. Or hold down left mouse button, move the mouse and release the button at the point.

**Note 1:**

It is important to choose an appropriate mouse snap method before drawing by mouse. **Mouse snap** dialog in Figure 5.15 can be opened by clicking **Mouse-Snap** menu in **PLOT-2D**.

For example, when you choose **Snap to Grid**, mouse cursor will automatically move to the nearest grid point.

Figure 5.15  
Mouse snap dialog



For [Enter X and Y](#),

1. Type in the coordinates of beginning and ending points.
2. Click [Draw](#) button.

**Note 2:**

You can draw many segments continuously by repeating above [Mouse Pickup](#) or [Enter X and Y](#) procedure.

[Arc Segment](#)

Switch to arc segment.

[Undo](#)

Undo the changes you just made for line segment.

[Finish](#)

Finish and exit from drawing the current group.

[Cancel](#)

Cancel and exit from drawing the current group.

## 5.5.2 Arc Segment

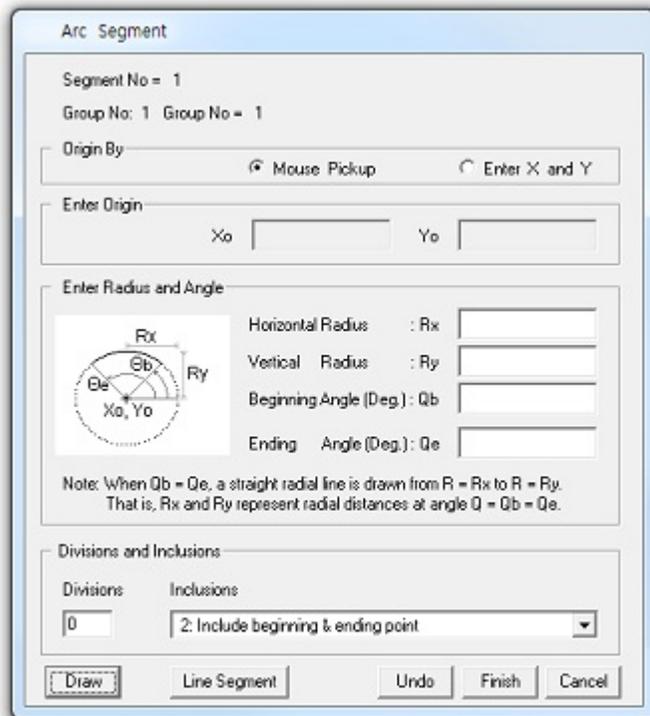


Figure 5.16 Arc segment dialog.

[Arc Segment](#) dialog is shown in Figure 5.16.

### [Segment No](#)

Current segment number will be displayed automatically.

### [Group No & Title](#)

Current group number and title will be displayed automatically.

### [Origin By](#)

Select [Mouse Pickup](#) or [Enter X and Y](#).

### Enter Origin

Coordinates of origin are required for [Enter X and Y](#).

### Enter Radius and Angle

Enter Horizontal & vertical radii, and beginning & ending angles.

### Divisions and Inclusions

Use following default values.

Number of divisions    **0**

Combo box selection    **2: Include beginning & ending point**

### Draw

Draw arc segment.

For [Mouse Pickup](#),

1. Type in  $R_x, R_y, \Theta_b, \Theta_e$
2. Click [Draw](#) button
3. Move the mouse to the origin and click left mouse button. Or hold down left mouse button, move the mouse and release the button at the origin.

For [Enter X and Y](#),

1. Type in  $X_o, Y_o, R_x, R_y, \Theta_b, \Theta_e$
2. Click [Draw](#) button

Refer to Note 1 & 2 in Section 5.5.1.

### Line Segment

Switch to line segment.

### Undo

Undo the changes you just made for arc segment.

### Finish

Finish and exit from drawing the current group.

### Cancel

Cancel and exit from drawing the current group.

## 5.6 Modifying Finite Element Meshes

[Group Mesh Generator](#) can be used to directly modify finite element meshes.

When you open input file, [Mesh Generator](#) reads the extension of the input file name and it assumes that the input file is the finite element mesh file if the extension is [.Mes](#).

Editing finite element meshes has three parts: [Nodal Boundary](#), [Nodal Coordinate](#) and [Element Material](#). These editing modes can be accessed from [Mesh](#) menu in [PLOT-2D](#) as shown in Figure 5.17.

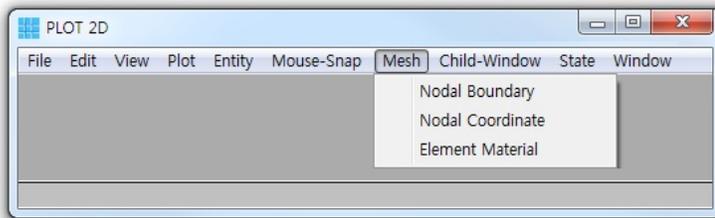


Figure 5.17 Menu for editing finite element mesh

It should be noted that once you edited the finite element meshes, modified finite element mesh is saved as [MeshFile.Mes](#) in the current working directory. The original input mesh file is not changed.

## 5.6.1 Edit Nodal Boundary

When you click **Nodal Boundary** from the **Mesh** menu, **Edit Boundary** dialog will be displayed.

### 5.6.1.1 Mouse Pickup

When you select **Mouse Pickup** mode as in Figure 5.18, you are supposed to select node number by mouse click. Click **Select Node** button.

Figure 5.18  
Edit boundary  
(**Mouse Pickup**)

New Boundary Code

Node Number By:  Mouse Pickup  Enter Node No

Enter Node No:

New Boundary Code

ISX	ISY	IFX	IFY	IRZ	IEX	IEY
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>				

= 0 Free to move in specified direction.  
= 1 Fixed in specified direction.

Select Node Cancel

Click the node by **Mouse Right Click**, edit boundary codes and then click **Apply Code** button in Figure 5.19.

Figure 5.19  
Edit boundary  
(**Apply Code**)

Select Node By Mouse Right Click

Node Number By:  Mouse Pickup  Enter Node No

Enter Node No:

New Boundary Code

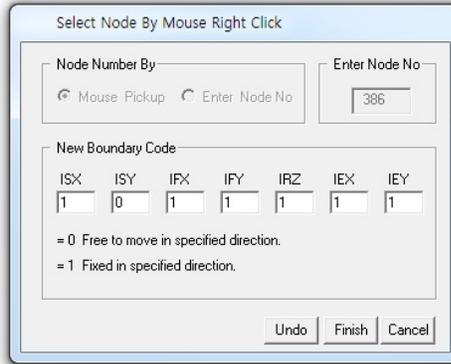
ISX	ISY	IFX	IFY	IRZ	IEX	IEY
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>				

= 0 Free to move in specified direction.  
= 1 Fixed in specified direction.

Apply Code Cancel

You can repeat the same procedure many times for other nodes. Once finished, click **Finish** button in Figure 5.20.

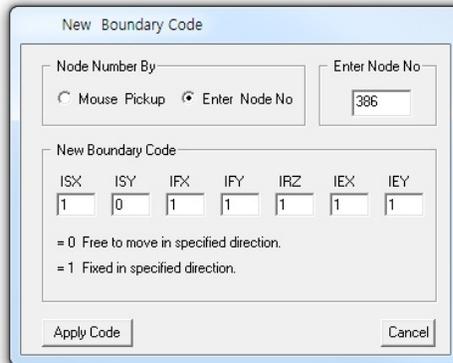
Figure 5.20  
Edit boundary (**Finish**)



### 5.6.1.2 Enter Node No

When you select **Enter Node No** mode as in Figure 5.21, you are supposed to type in node number. Edit boundary codes and then click **Apply Code** button.

Figure 5.21  
Edit boundary (**Enter Node No**)



You can repeat the same procedure many times for other nodes. Once finished, click **Finish** button.

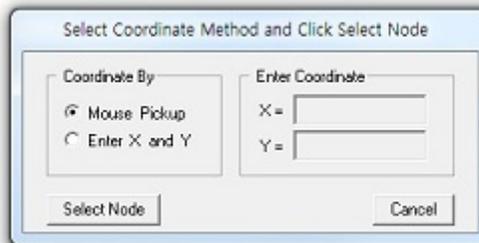
## 5.6.2 Edit Nodal Coordinate

When you click **Nodal Coordinate** from the **Mesh** menu, **Edit Coordinate** dialog will be displayed.

### 5.6.2.1 Mouse Pickup

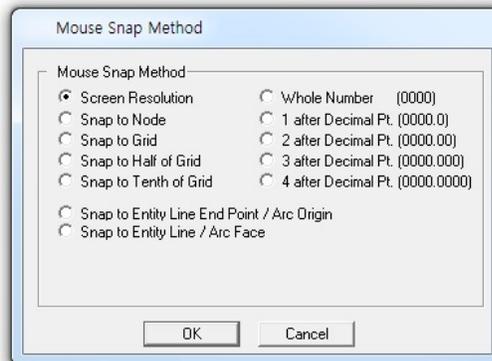
When you select **Mouse Pickup** mode as in Figure 5.22, you are supposed to select node number by mouse click. Click **Select Node** button.

Figure 5.22  
Edit coordinate  
(**Mouse Pickup**)



Select the node number by **Mouse Right Click** and then move the coordinate by **Mouse Left Click**. It is convenient to select an appropriate **Mouse-Snap** method in Figure 5.23 before moving the coordinates.

Figure 5.23  
Mouse snap method



You can repeat the same procedure many times for other nodes. Once finished, click **Finish** button in Figure 5.24.

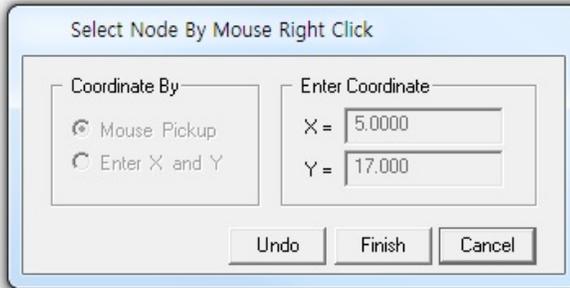


Figure 5.24 Edit coordinate (**Finish**)

### 5.6.2.2 Enter X and Y

When you select **Enter X and Y** mode as in Figure 5.25, you are supposed to type in nodal coordinates. Type in X and Y coordinates and then click **Apply** button.

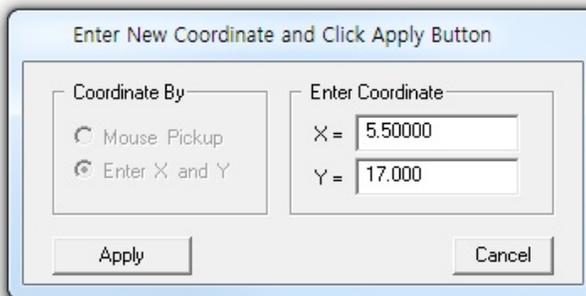


Figure 5.25 Edit coordinate (**Enter X and Y**)

You can repeat the same procedure many times for other nodes. Once finished, click **Finish** button.

### 5.6.3 Edit Element Material

When you click **Element Material** from the **Mesh** menu, **Edit Element Material** dialog will be displayed.

#### 5.6.3.1 Mouse Pickup

When you select **Mouse Pickup** mode as in Figure 5.26, you are supposed to select element number by mouse click. Click **Select Element** button.

Figure 5.26  
Edit element material  
(**Mouse Pickup**)

New Material Parameter

Element Number By:  Mouse Pickup  Enter Element No

Element No: 1

New Material Parameter

MATNo	KS	KF	TBJwL
1	0	1	0.00000

KS = 0:Solid, > 0:Joint Face No, -1:Detonation  
KF = 0:Fluid, TBJwL: Det. Time for KS=1

Select Element Cancel

Click the element by **Mouse Right Click**, edit material parameters and then click **Apply** button in Figure 5.27.

Figure 5.27  
Edit element material  
(**Apply**)

Select Element By Mouse Right Click

Element Number By:  Mouse Pickup  Enter Element No

Element No: 334

New Material Parameter

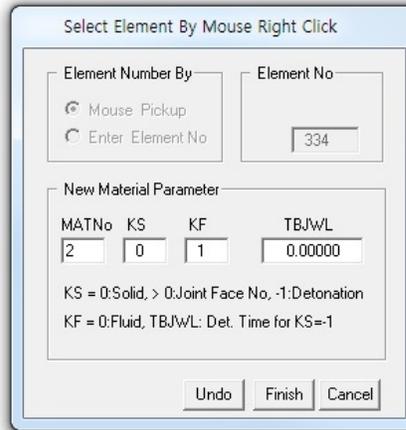
MATNo	KS	KF	TBJwL
2	0	1	0.00000

KS = 0:Solid, > 0:Joint Face No, -1:Detonation  
KF = 0:Fluid, TBJwL: Det. Time for KS=1

Apply Cancel

You can repeat the same procedure many times for other elements. Once finished, click **Finish** button in Figure 5.28.

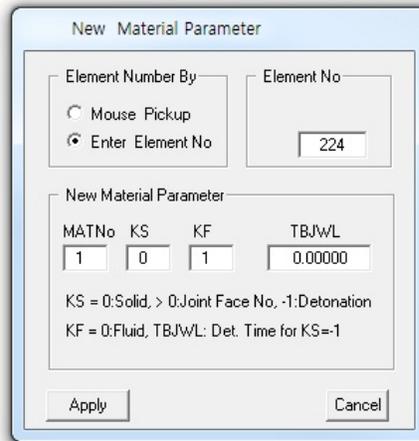
Figure 5.28  
Edit element material  
(**Finish**)



### 5.6.3.2 Enter Element No

When you select **Enter Element No** mode as in Figure 5.29, you are supposed to type in element number. Edit material parameters and then click **Apply** button.

Figure 5.29  
Edit element material  
(**Enter Element No**)



You can repeat the same procedure many times for other elements. Once finished, click **Finish** button.

## 5.7 Entities

**Entities** are graphical objects which are mainly used to assist editing the geometry of groups and elements.

There are four types of entities: **Mark**, **Line**, **Arc**, and **Text**.

Entities can be accessed from **Entity** menu in **PLOT-2D** as shown in Figure 5.30.

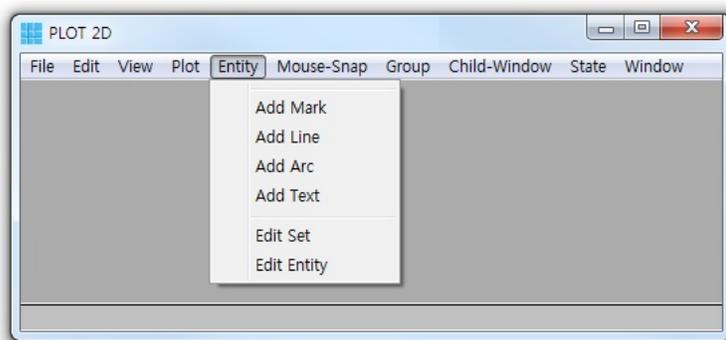


Figure 5.30 Entity menu

Entity menu has six parts:

**Add Mark**, **Add Line**, **Add Arc**, **Add Text**, **Edit Set** and **Edit Entity**.

First four **Add Entities** are to build new entities.

**Edit Set** is to assign entity set so that each plot number can include only selected entities.

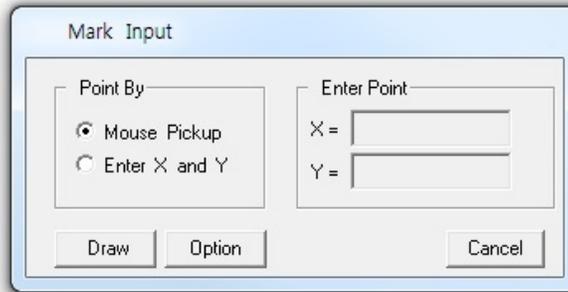
**Edit Entity** is to modify, delete or replace the selected entity.

### 5.7.1 Add Mark

Marks are graphical symbols which are mainly used to assist editing the geometry of groups and elements.

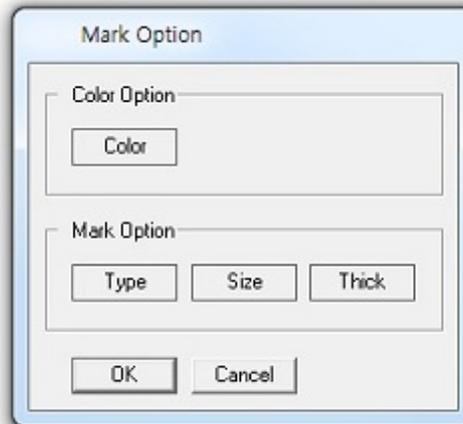
When you select **Add Mark** submenu, **Mark Input** dialog in Figure 5.31 is displayed.

Figure 5.31  
Mark input  
(Mouse Pickup)



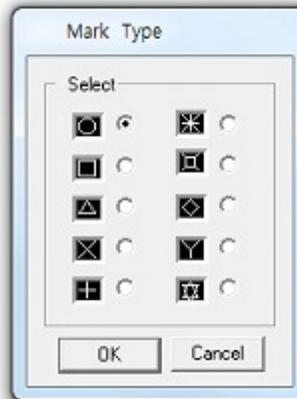
**Option** button is to show **Mark Option** in Figure 5.32.

Figure 5.32  
Mark option dialog



Available [Mark Types](#) are shown in Figure 5.33.

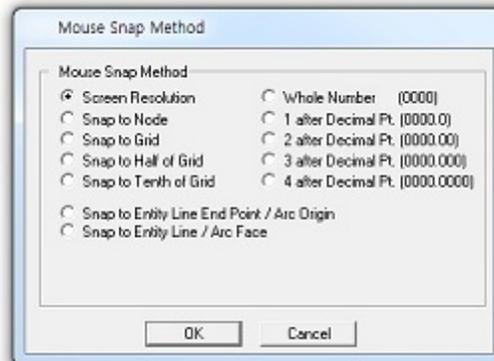
Figure 5.33 Mark type dialog



### 5.7.1.1 Mouse Pickup

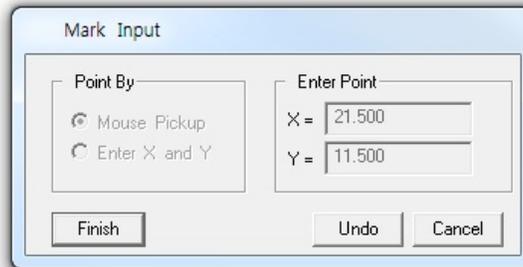
When you select [Mouse Pickup](#) mode as in Figure 5.31, you are supposed to select the mark center position by mouse click. Click [Draw](#) button and then move the position by [Mouse Left Click](#). It is convenient to select an appropriate [Mouse-Snap](#) method in Figure 5.34 before moving the position.

Figure 5.34  
Mouse snap method



Once finished, click **Finish** button in Figure 5.35.

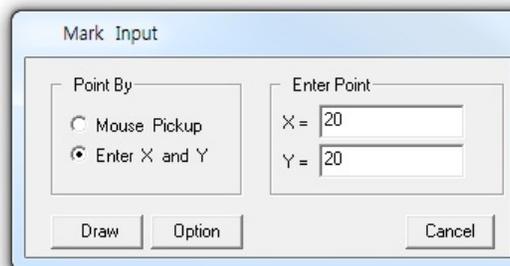
Figure 5.35  
Mark input  
(**Finish**)



### 5.7.1.2 Enter X and Y

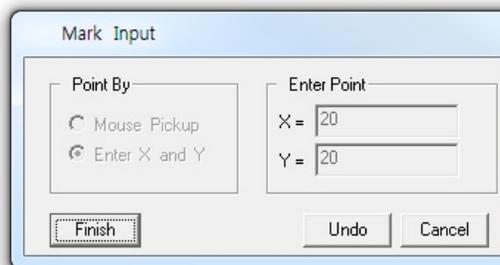
When you select **Enter X and Y** mode as in Figure 5.36, you are supposed to type in the coordinates of the mark center position. Click **Draw** button.

Figure 5.36  
Mark input  
(**Enter X and Y**)



Once finished, click **Finish** button in Figure 5.37.

Figure 5.37  
Mark input  
(**Finish**)

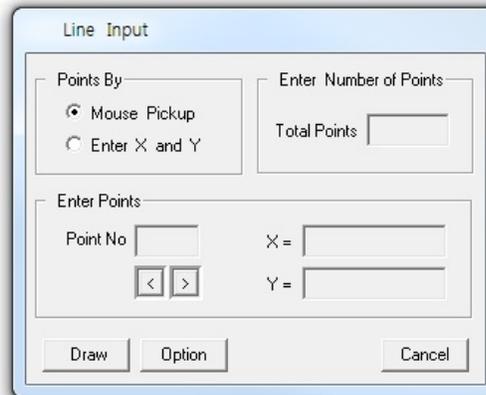


## 5.7.2 Add Line

Lines are graphical objects which are mainly used to assist editing the geometry of groups and elements.

When you select **Add Line** submenu, **Line Input** dialog in Figure 5.38 is displayed.

Figure 5.38  
Line input  
(**Mouse Pickup**)

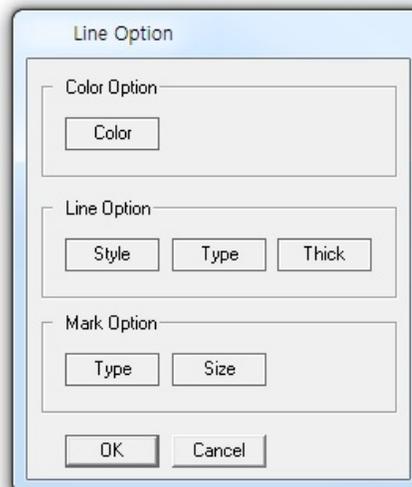


The **Line Input** dialog box is used for defining a line. It features the following controls:

- Points By:** Radio buttons for **Mouse Pickup** (selected) and **Enter X and Y**.
- Enter Number of Points:** A **Total Points** input field.
- Enter Points:** A **Point No** input field, **X =** and **Y =** input fields, and left/right navigation arrows.
- Buttons: **Draw**, **Option**, and **Cancel**.

**Option** button is to show **Line Option** in Figure 5.39.

Figure 5.39  
Line option dialog



The **Line Option** dialog box allows for customizing the appearance of a line. It includes the following sections:

- Color Option:** A **Color** button.
- Line Option:** Buttons for **Style**, **Type**, and **Thick**.
- Mark Option:** Buttons for **Type** and **Size**.
- Buttons: **OK** and **Cancel**.

Available [Line Styles](#) are shown in Figure 5.40.

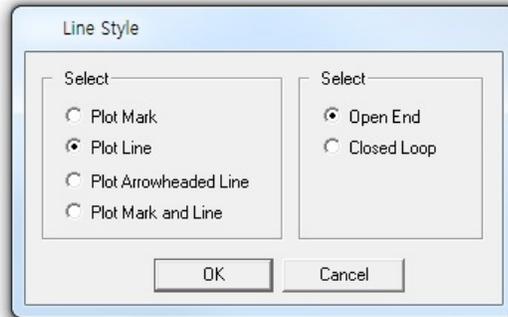


Figure 5.40 Line style dialog

Available [Line Types](#) are shown in Figure 5.41.



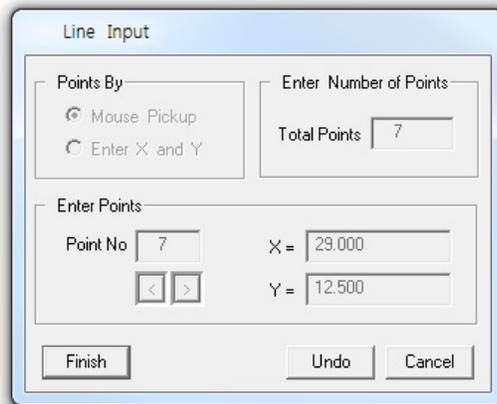
Figure 5.41 Line type dialog

### 5.7.2.1 Mouse Pickup

When you select **Mouse Pickup** mode as in Figure 5.38, you are supposed to select the line end point by mouse click. Click **Draw** button and then select the point by **Mouse Left Click**.

It is convenient to select an appropriate **Mouse-Snap** method in Figure 5.34 before moving the coordinate.

You can click many points to build continuous lines. Once finished, click **Finish** button in Figure 5.42.



The image shows a dialog box titled "Line Input". It has two main sections: "Points By" and "Enter Points".

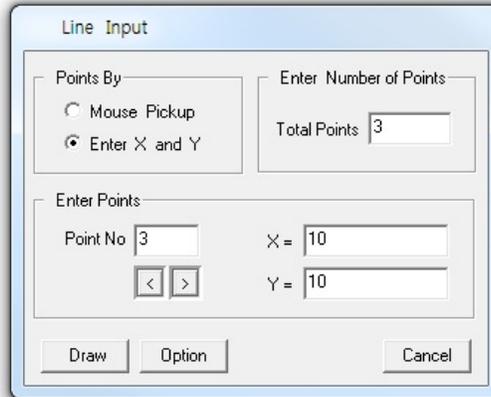
- Points By:** Contains two radio buttons. "Mouse Pickup" is selected, and "Enter X and Y" is unselected.
- Enter Number of Points:** Contains a text box labeled "Total Points" with the value "7".
- Enter Points:** Contains a text box labeled "Point No" with the value "7", and two arrow buttons (< and >). To the right, there are two text boxes: "X =" with the value "29.000" and "Y =" with the value "12.500".
- Buttons:** At the bottom, there are three buttons: "Finish", "Undo", and "Cancel".

Figure 5.42 Line input (**Finish**)

### 5.7.2.2 Enter X and Y

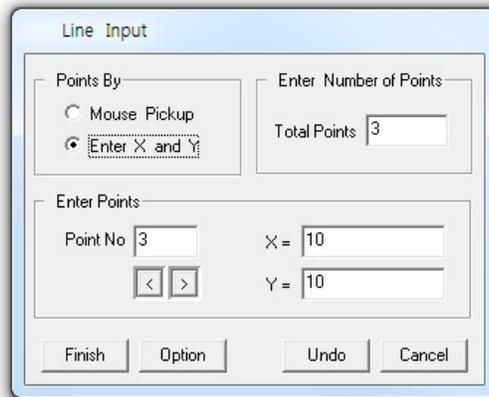
When you select **Enter X and Y** mode as in Figure 5.43, you are supposed to type the coordinates of the line. Click **Draw** button.

Figure 5.43  
Line input  
(**Enter X and Y**)



And then click **Finish** button in Figure 5.44.

Figure 5.44  
Line input  
(**Finish**)

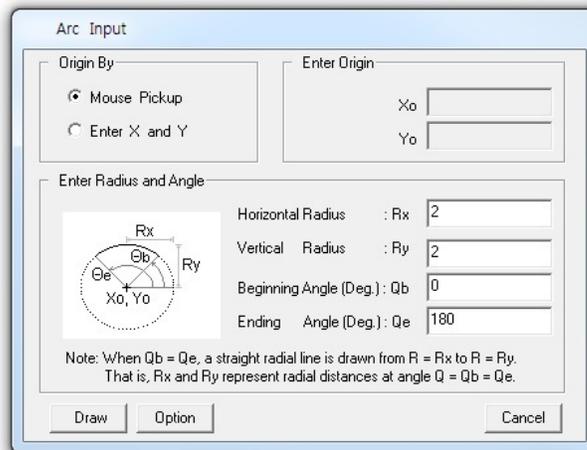


### 5.7.3 Add Arc

Arcs are graphical objects which are mainly used to assist editing the geometry of groups and elements.

When you select **Add Arc** submenu, **Arc Input** dialog in Figure 5.45 is displayed.

Figure 5.45  
Arc input  
(Mouse Pickup)

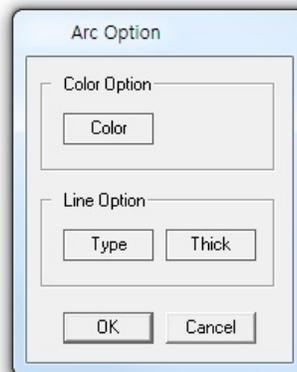


The **Arc Input** dialog box is used to define an arc. It contains the following sections:

- Origin By:** Radio buttons for **Mouse Pickup** (selected) and **Enter X and Y**.
- Enter Origin:** Input fields for  $X_o$  and  $Y_o$ .
- Enter Radius and Angle:** A diagram shows an arc with origin  $(X_o, Y_o)$ , horizontal radius  $R_x$ , vertical radius  $R_y$ , beginning angle  $Q_b$ , and ending angle  $Q_e$ . Input fields for  $R_x$  (2),  $R_y$  (2),  $Q_b$  (0), and  $Q_e$  (180) are provided.
- Note:** When  $Q_b = Q_e$ , a straight radial line is drawn from  $R = R_x$  to  $R = R_y$ . That is,  $R_x$  and  $R_y$  represent radial distances at angle  $Q = Q_b = Q_e$ .
- Buttons: **Draw**, **Option**, and **Cancel**.

**Option** button is to show **Arc Option** in Figure 5.46.

Figure 5.46 Arc option dialog



The **Arc Option** dialog box allows for customizing the arc's appearance. It contains the following sections:

- Color Option:** A **Color** button to select the arc's color.
- Line Option:** **Type** and **Thick** buttons to adjust the arc's line style.
- Buttons: **OK** and **Cancel**.

### 5.7.3.1 Mouse Pickup

When you select **Mouse Pickup** mode as in Figure 5.45, you are supposed to select the arc origin by mouse click.

Type in **Horizontal Radius**, **Vertical Radius**, **Beginning Angle** and **Ending Angle**.

Click **Draw** button and then select the origin by **Mouse Left Click**. It is convenient to select an appropriate **Mouse-Snap** method in Figure 5.34 before moving the coordinate.

Once finished, click **Finish** button in Figure 5.47.

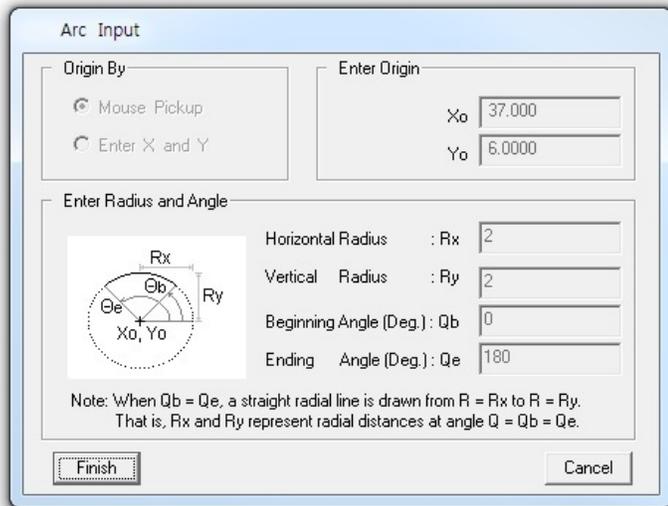


Figure 5.47 Arc input (**Finish**)

### 5.7.3.2 Enter X and Y

When you select **Enter X and Y** mode as in Figure 5.48, you are supposed to type in the coordinates of the arc origin.

Type in **Horizontal Radius**, **Vertical Radius**, **Beginning Angle** and **Ending Angle**. And then click **Draw** button.

Figure 5.48  
Arc input  
(Enter X and Y)

Arc Input

Origin By:

Mouse Pickup

Enter X and Y

Enter Origin:

Xo: 10

Yo: 10

Enter Radius and Angle:

Horizontal Radius : Rx: 2

Vertical Radius : Ry: 2

Beginning Angle (Deg.): Qb: 0

Ending Angle (Deg.): Qe: 180

Note: When Qb = Qe, a straight radial line is drawn from R = Rx to R = Ry. That is, Rx and Ry represent radial distances at angle Q = Qb = Qe.

Draw Option Cancel

Once finished, click **Finish** button in Figure 5.49.

Figure 5.49  
Arc input  
(Finish)

Arc Input

Origin By:

Mouse Pickup

Enter X and Y

Enter Origin:

Xo: 10

Yo: 10

Enter Radius and Angle:

Horizontal Radius : Rx: 2

Vertical Radius : Ry: 2

Beginning Angle (Deg.): Qb: 0

Ending Angle (Deg.): Qe: 180

Note: When Qb = Qe, a straight radial line is drawn from R = Rx to R = Ry. That is, Rx and Ry represent radial distances at angle Q = Qb = Qe.

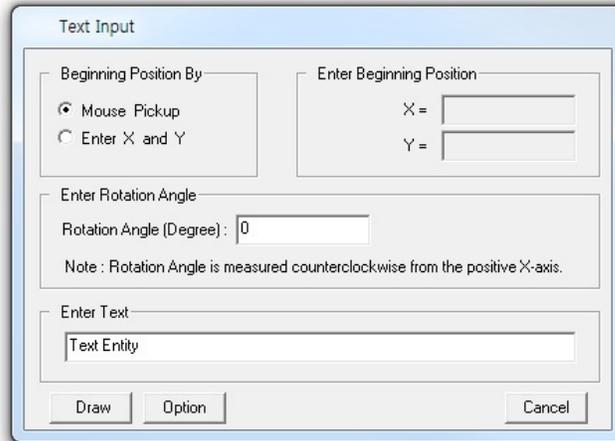
Finish Undo Cancel

### 5.7.4 Add Text

Texts are characters which are mainly used to assist describing the geometry of groups and elements.

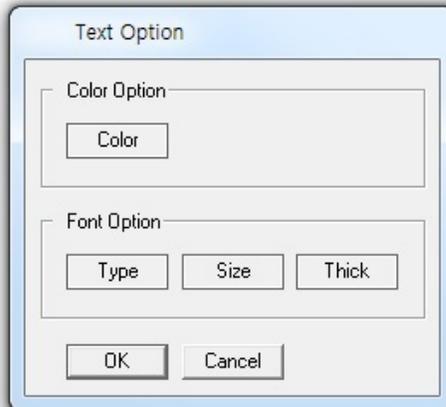
When you select **Add Text** submenu, **Text Input** dialog in Figure 5.50 is displayed.

Figure 5.50  
Text input  
(Mouse Pickup)



**Option** button is to show **Text Option** in Figure 5.51.

Figure 5.51  
Text option dialog



Available **Font Sizes** are shown in Figure 5.52.

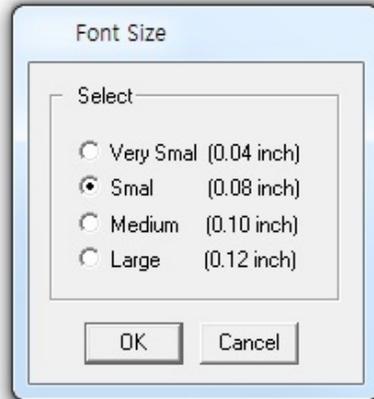


Figure 5.52 Font size dialog

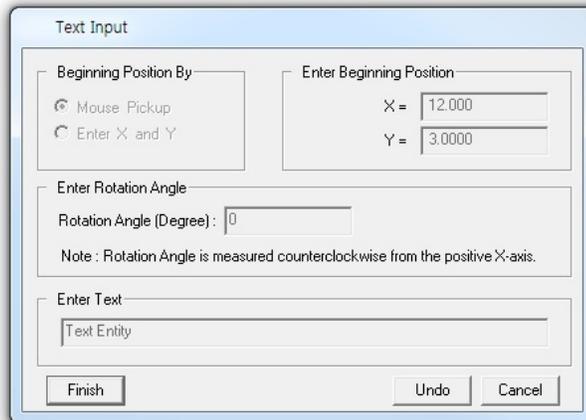
### 5.7.4.1 Mouse Pickup

When you select **Mouse Pickup** mode as in Figure 5.50, you are supposed to select the beginning position of text by mouse click.

Type in **Rotation Angle** and **Text**.

Click **Draw** button and then select the beginning position of the text by **Mouse Left Click**. It is convenient to select an appropriate **Mouse-Snap** method in Figure 5.34 before moving the coordinate.

Once finished, click **Finish** button in Figure 5.53.



The image shows a dialog box titled "Text Input". It contains several sections for user input:

- Beginning Position By:** Two radio buttons are present. "Mouse Pickup" is selected, and "Enter X and Y" is unselected.
- Enter Beginning Position:** Two input fields are shown. The "X =" field contains the value "12.000" and the "Y =" field contains the value "3.0000".
- Enter Rotation Angle:** A text input field labeled "Rotation Angle (Degree):" contains the value "0". Below this field is a note: "Note : Rotation Angle is measured counterclockwise from the positive X-axis."
- Enter Text:** A text input field labeled "Text Entity:" contains the text "Text Entity".

At the bottom of the dialog box, there are three buttons: "Finish", "Undo", and "Cancel".

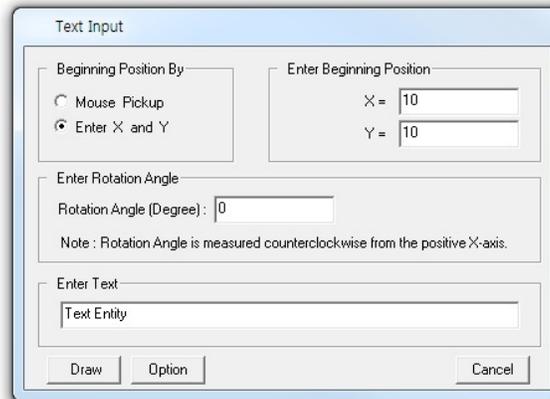
Figure 5.53 Text input (**Finish**)

### 5.7.4.2 Enter X and Y

When you select **Enter X and Y** mode as in Figure 5.54, you are supposed to type in the coordinates of beginning position of text.

Type in **Rotation Angle** and **Text**. And then click **Draw** button.

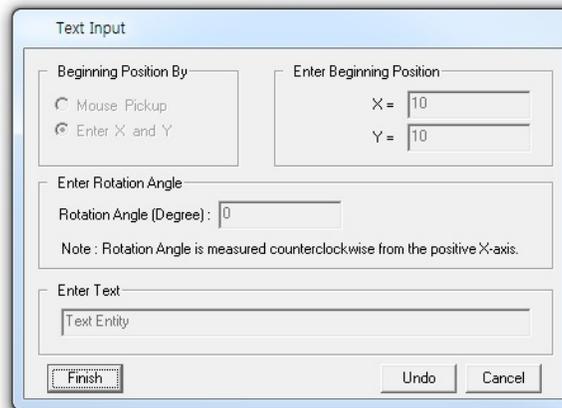
Figure 5.54  
Text input  
(Enter X and Y)



The screenshot shows the 'Text Input' dialog box. It has a title bar 'Text Input'. Inside, there are three main sections: 'Beginning Position By', 'Enter Beginning Position', and 'Enter Rotation Angle'. The 'Beginning Position By' section has two radio buttons: 'Mouse Pickup' (unselected) and 'Enter X and Y' (selected). The 'Enter Beginning Position' section has two input fields: 'X = 10' and 'Y = 10'. The 'Enter Rotation Angle' section has a text input field with '0' and a note: 'Note : Rotation Angle is measured counterclockwise from the positive X-axis.' Below these sections is an 'Enter Text' section with a text input field containing 'Text Entity'. At the bottom, there are three buttons: 'Draw', 'Option', and 'Cancel'.

Once finished, click **Finish** button in Figure 5.55.

Figure 5.55  
Text input  
(Finish)



The screenshot shows the 'Text Input' dialog box. It has a title bar 'Text Input'. Inside, there are three main sections: 'Beginning Position By', 'Enter Beginning Position', and 'Enter Rotation Angle'. The 'Beginning Position By' section has two radio buttons: 'Mouse Pickup' (unselected) and 'Enter X and Y' (selected). The 'Enter Beginning Position' section has two input fields: 'X = 10' and 'Y = 10'. The 'Enter Rotation Angle' section has a text input field with '0' and a note: 'Note : Rotation Angle is measured counterclockwise from the positive X-axis.' Below these sections is an 'Enter Text' section with a text input field containing 'Text Entity'. At the bottom, there are three buttons: 'Finish', 'Undo', and 'Cancel'.

## 5.7.5 Edit Set

**Edit Set** is to assign **Entity Set** as shown in Figure 5.56.

**Edit Set** consists of two parts:

1. Enter **Entity Set Number** and assign **Entity Numbers**.
2. Enter **Plot Number** and assign **Entity Set Number**.

Every time **Enter Set Number** or **Plot Number** is changed, click **Update** button. When finished, click **Finish** button.

Figure 5.56  
Assign entity set dialog

Assign Entity Set

Enter Entity Set Number and Assign Entity Numbers

Entity Set Number  Total Number of Entity Set

None  All  Lists to Include  Lists to Exclude

Enter Plot Number and Assign Entity Set Number

Plot Number  Entity Set Number

### 5.7.5.1 Enter Entity Set No & Assign Entity No

Here, you enter **Entity Set Number**, **Total Number of Entity Set** and then select **Option** for the current set.

When **Lists to Include** option is selected, type in entity numbers to be included in the current set.

When **Lists to Exclude** option is selected, type in entity numbers to be excluded in the current set.

### 5.7.5.2 Enter Plot No & Assign Entity Set No

Here, you enter **Plot Number** and assign **Entity Set Number**.

## 5.7.6 Edit Entity

**Edit Entity** is to modify, delete or replace the selected entity as shown in Figure 5.57.

Figure 5.57  
Edit entity dialog

The screenshot shows a dialog box titled "Edit Entity". It contains three numbered sections:

- 1. Enter Entity Number: A text box with "Entity Number" and the value "1".
- 2. Select Action: Three radio buttons labeled "Modify", "Delete", and "Replace". The "Replace" button is selected.
- 3. Select New Entity Type: Four radio buttons labeled "Mark", "Line", "Arc", and "Text". The "Line" button is selected.

At the bottom of the dialog are "OK" and "Cancel" buttons.

### 5.7.6.1 Modify

**Modify** is to modify the current entity.

When **OK** button is clicked, **Entity Input** dialog corresponding to the current entity is displayed. Follow the same procedure as described in [Add Entity](#).

### 5.7.6.2 Delete

**Delete** is to delete the current entity.

### 5.7.6.3 Replace

**Replace** is to replace the current entity by new entity type.

When **OK** button is clicked, **Entity Input** dialog corresponding to the new entity type is displayed. Follow the same procedure as described in [Add Entity](#).



## Block Mesh User's Manual

### 6.1 Introduction

[Block Mesh Generator](#) is a three-dimensional CAD program specially designed to build block mesh which can be used to generate finite element mesh with the aid of program [PRESMAP-GP](#).

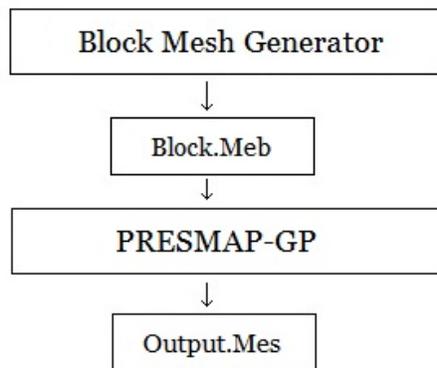


Figure 6.1 Flow diagram of block mesh generation

Block.Meb contains block mesh data that can be generated or modified by [Block Mesh Generator](#). The file Block.Meb is used as input to the program [PRESMAP-GP](#), thereby generating finite element mesh file Output.Mes.

Block Mesh Generator can be accessed through **SMAP** menu **Run** or **Plot** as explained in Section 6.2.

**PRESMAP-GP** can be accessed from **SMAP** menu:

**Run** → **Mesh Generator** → **PreSmap** → **Presmap GP**.

This program can also be accessed indirectly by executing **Show F. E. Mesh** in **Block Editor** dialog in Section 6.5.8.

## 6.2 Block Mesh Generator

Block Mesh Generator can be accessed by selecting the following menu items in **SMAP**:

**Run** → **Mesh Generator** → **Block Mesh** or

**Plot** → **Mesh** → **Block Mesh**

When you build new block mesh, **PLOT-3D** program in Figure 6.2 is displayed along with **Work Plane Editor** in Figure 6.3.

Click **Block Editor** toolbar in Figure 6.4. Building new block is discussed in detail in Section 6.5.8.

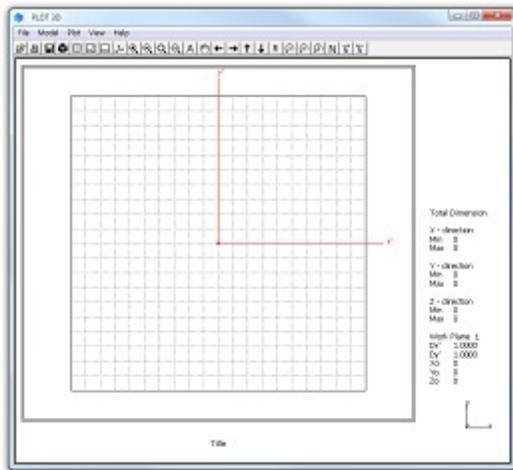


Figure 6.2 Prebuilt work plane on PLOT-3D

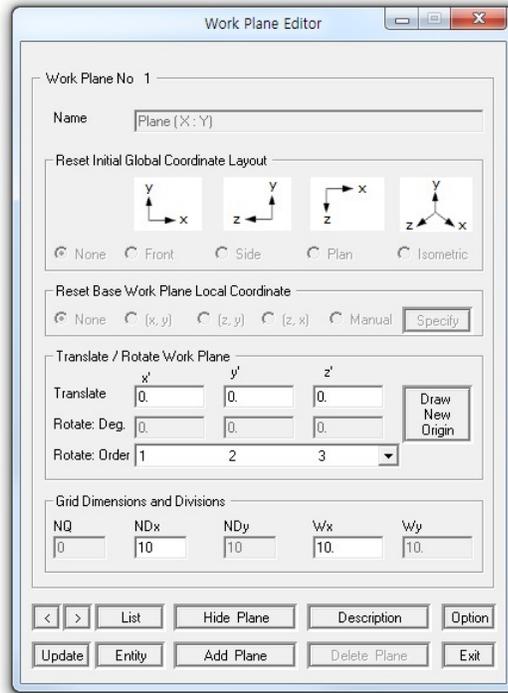


Figure 6.3 Prebuilt work plane editor

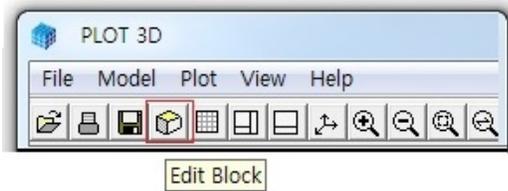


Figure 6.4 Block editor toolbar

When you open existing block mesh, Select **Open** in **SMAP** menu as shown in Figure 6.5 and then select the input file. Block mesh will be displayed on **PLOT-3D** as in Figure 6.6.

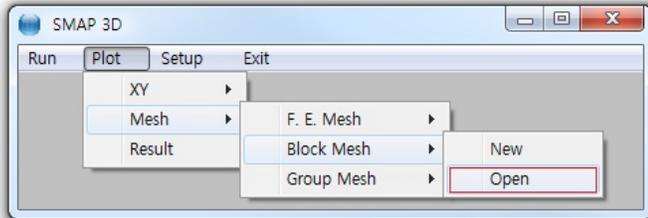


Figure 6.5 Open input file dialog

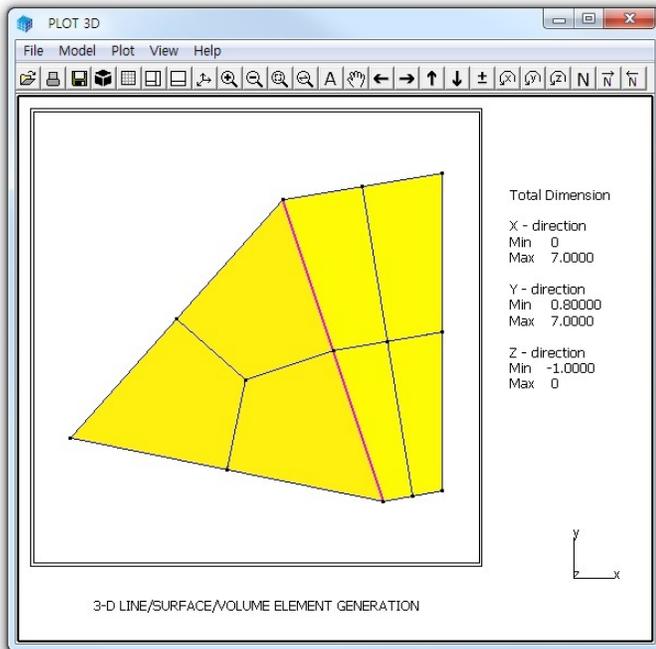


Figure 6.6 Block mesh on PLOT-3D

### 6.3 Work Plane

**Work Planes** are rectangular planes with grid lines and local coordinate axes, which are mainly used to assist editing the geometry of blocks and elements.

**Work Plane Editor** can be accessed by selecting the following menu items in **PLOT-3D**:

**Model → Work Plane → Show Editor**

or by clicking **Work Plane** toolbar as shown in Figure 6.7.

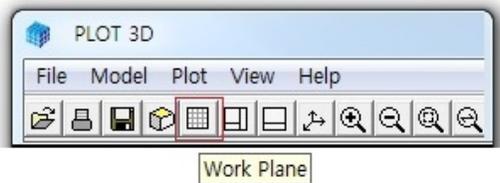


Figure 6.7 Work plane toolbar

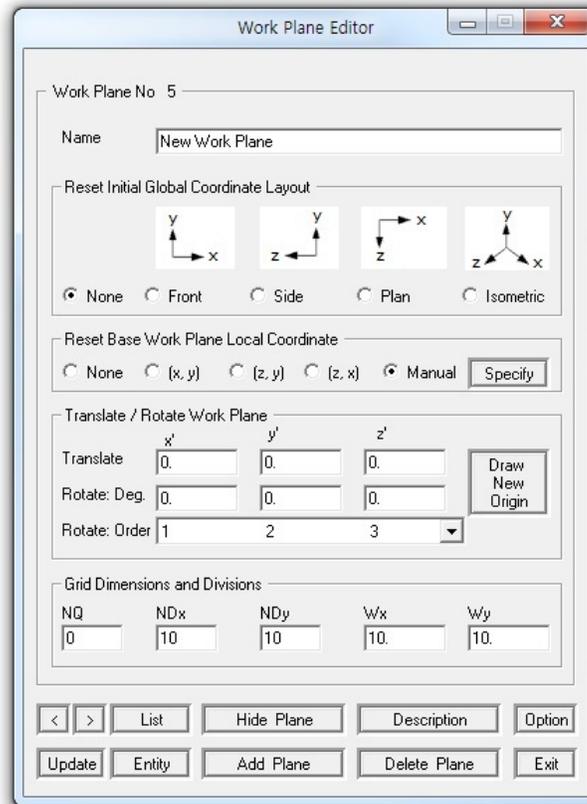
**Work Plane Editor** dialog in Figure 6.8 consists of following six parts:

- Name
- Reset Initial Global Coordinate Layout
- Reset Base Work Plane Local Coordinate
- Translate / Rotate Work Plane
- Grid Dimensions and Divisions
- Command Buttons

First three work planes are prebuilt work planes:

(X : Y), (Z : Y) and (Z : X) planes. New work planes can be added by copying one of these prebuilt planes.

Figure 6.8  
Work plane editor



### 6.3.1 Name

**Name** is work plane name you can specify for identification.

### 6.3.2 Reset Initial Global Coordinate Layout

This is used to reset initial global coordinate layout. You can select **Front**, **Side**, **Plan** or **Isometric** views. Once selected, click **Update** button to see the selected layout.

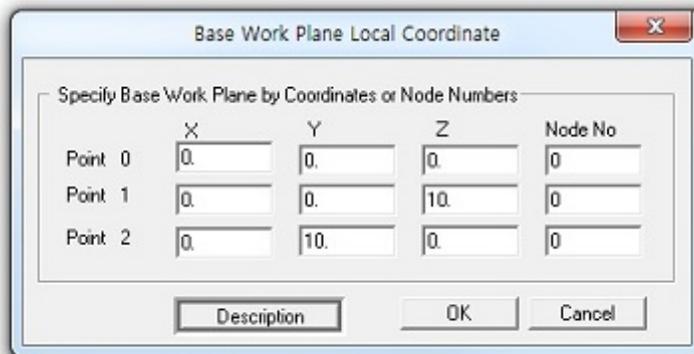
### 6.3.3 Reset Base Work Plane Local Coordinate

This is used to reset base work plane local coordinate.

You can select (x, y), (z, y), (z, x) or Manual.

For Manual, click Specify button to display Base Work Plane Local Coordinate dialog in Figure 6.9. Base work plane can be specified either by coordinates of three points or by three node numbers.

Once selected, click Update button to see the selected local coordinate.



The dialog box titled "Base Work Plane Local Coordinate" contains a table for specifying coordinates and node numbers for three points. The table has columns for X, Y, Z, and Node No. Below the table are buttons for Description, OK, and Cancel.

	X	Y	Z	Node No
Point 0	0.	0.	0.	0
Point 1	0.	0.	10.	0
Point 2	0.	10.	0.	0

Figure 6.9 Base work plane local coordinate dialog

### 6.3.4 Translate / Rotate Work Plane

This is used to translate and rotate work plane.

When you rotate about more than one axis, select appropriate rotation order from the list box.

Click [Draw New Origin](#) button in Figure 6.8 to display [Work Plane Origin](#) dialog in Figure 6.10. This is a convenient way of moving the work plane origin.

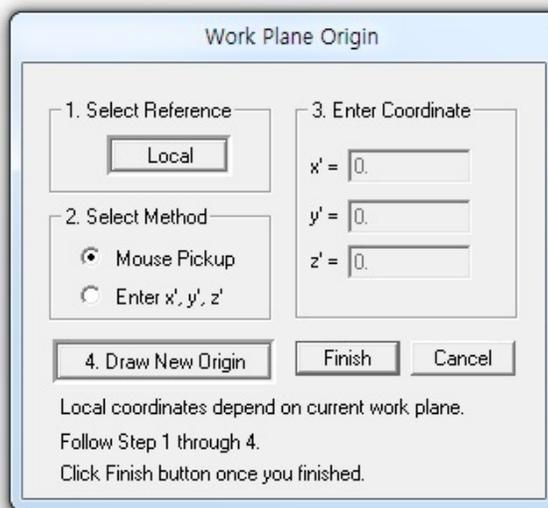


Figure 6.10 Work plane origin dialog

### 6.3.5 Grid Dimensions and Divisions

You can specify quadrant (NQ), grid divisions (NDx, NDy), and grid dimensions (Wx, Wy) as shown in work plane description in Figure 6.11.

Normally, you set the grid dimensions such that they include all blocks.

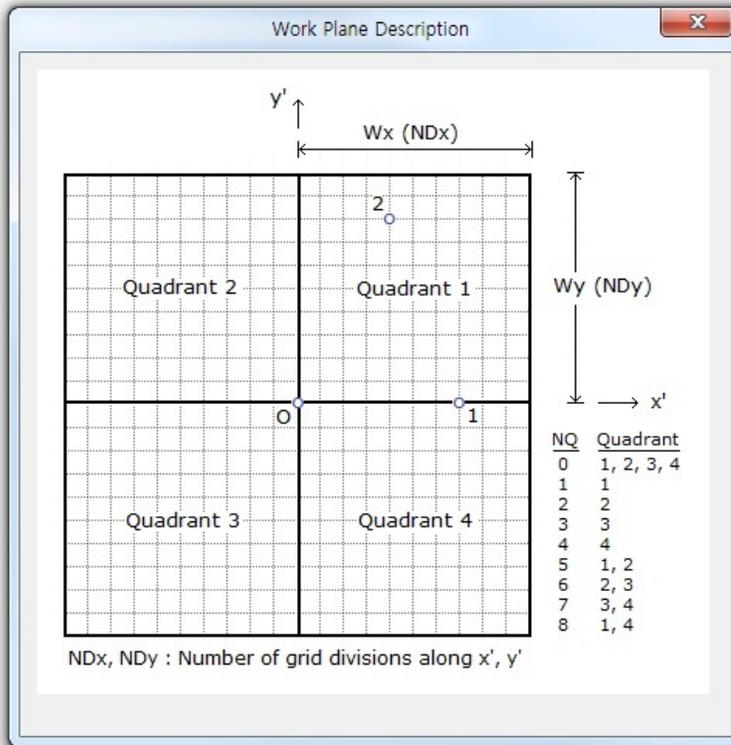


Figure 6.11 Work plane description

### 6.3.6 Command Buttons

Command buttons are shown on the bottom of [Work Plane Editor](#) dialog.

#### [List](#)

This is used to list all available work planes in Figure 6.12.

When you click [OK](#) button, selected work plane will be displayed as the current work plane.

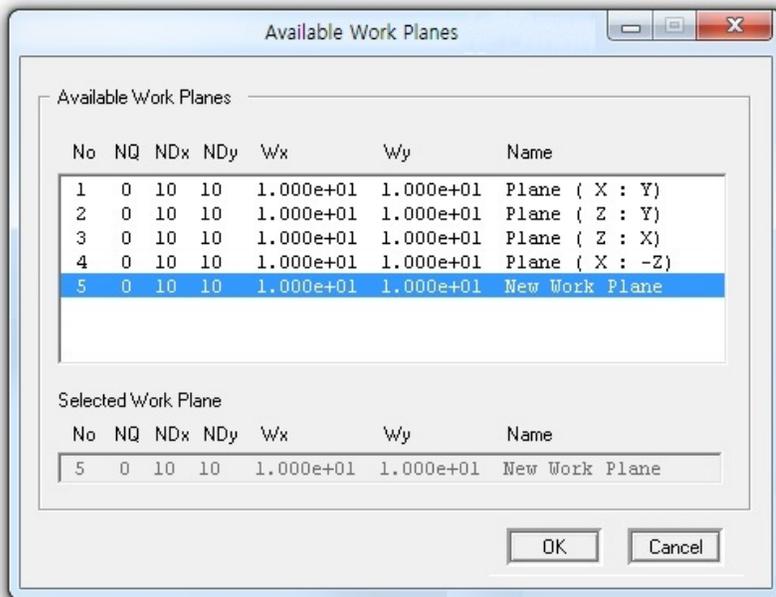


Figure 6.12 Work plane list

#### [Hide Plane](#)

This is used to hide the work plane and entities on the screen.

#### [Description](#)

This is used to show the description of work plane as shown in Figure 6.11.

[Option](#)

This is used to open work plane option dialog in Figure 6.13.

Click [Update](#) button on this dialog to see the changes made by selected options.

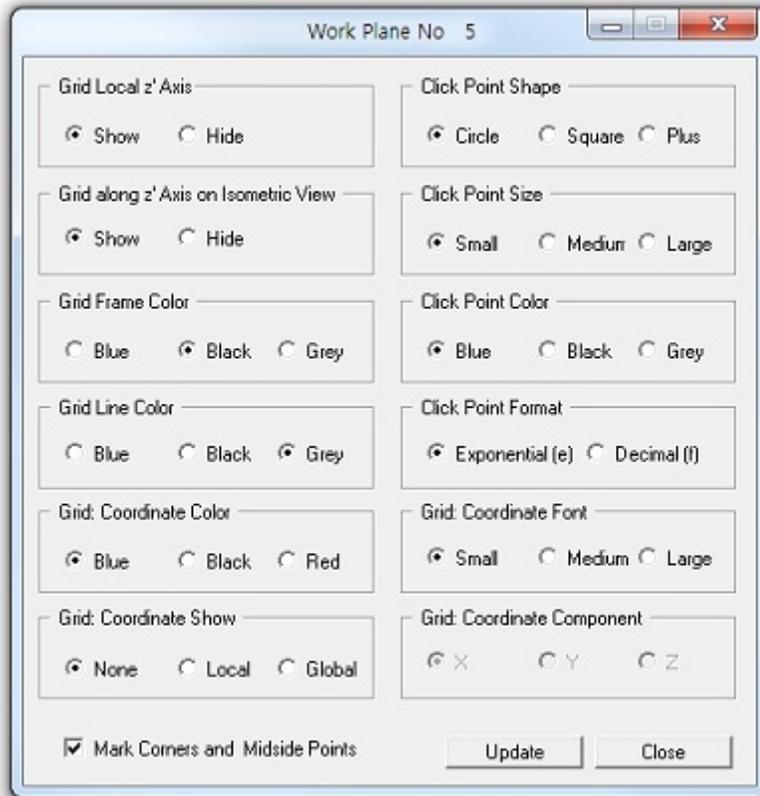


Figure 6.13 Work plane option dialog

[Update](#)

This is used to update the current work plane parameters shown on the [Work Plane Editor](#) dialog.

[Entity](#)

This is used to show [Entity Editor](#) dialog in Figure 6.17.

Entities are geometric objects under the current work plane, which are mainly used to assist editing the geometry of blocks and elements. Section 6.4 discusses entities in detail.

[Add Plane](#)

This is used to add new work plane.

New work plane is made by copying the work plane shown on the dialog. Once you edit work plane parameters, click [Update](#) button in the [Work Plane Editor](#) dialog to see the changes.

[Delete Plane](#)

This is used to delete the current work plane.

[Exit](#)

This is used to hide the work plane and exit from the dialog.

### 6.3.7 Prebuilt Work Planes

First three work planes are prebuilt work planes:  
(x : y), (z : y) and (z : x) planes.

These [Prebuilt Work Planes](#) can be accessed by selecting the following menu items in [PLOT-3D](#) as shown in Figure 6.14:

[Model](#) → [Work Plane](#)

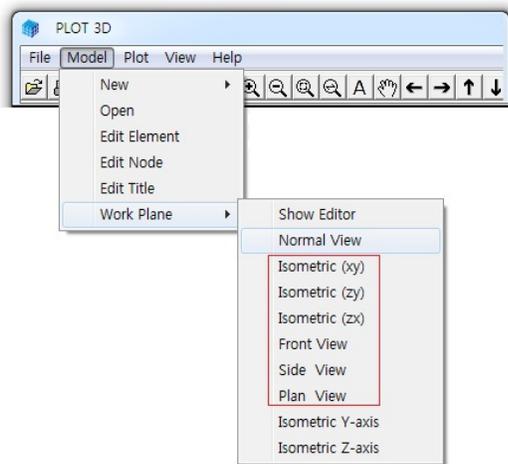


Figure 6.14 Prebuilt work plane menus

or by clicking [Axis](#) toolbar as shown in Figure 6.15.

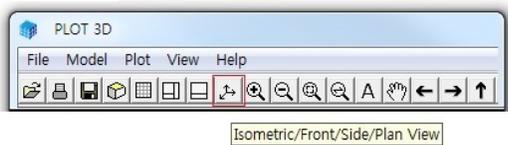


Figure 6.15 Axis toolbar

There are six different views associated with these prebuilt work planes as shown in Figure 6.16: [Isometric \(xy\)](#), [Isometric \(zy\)](#), [Isometric \(zx\)](#), [Front](#), [Side](#) and [Plan](#) views.

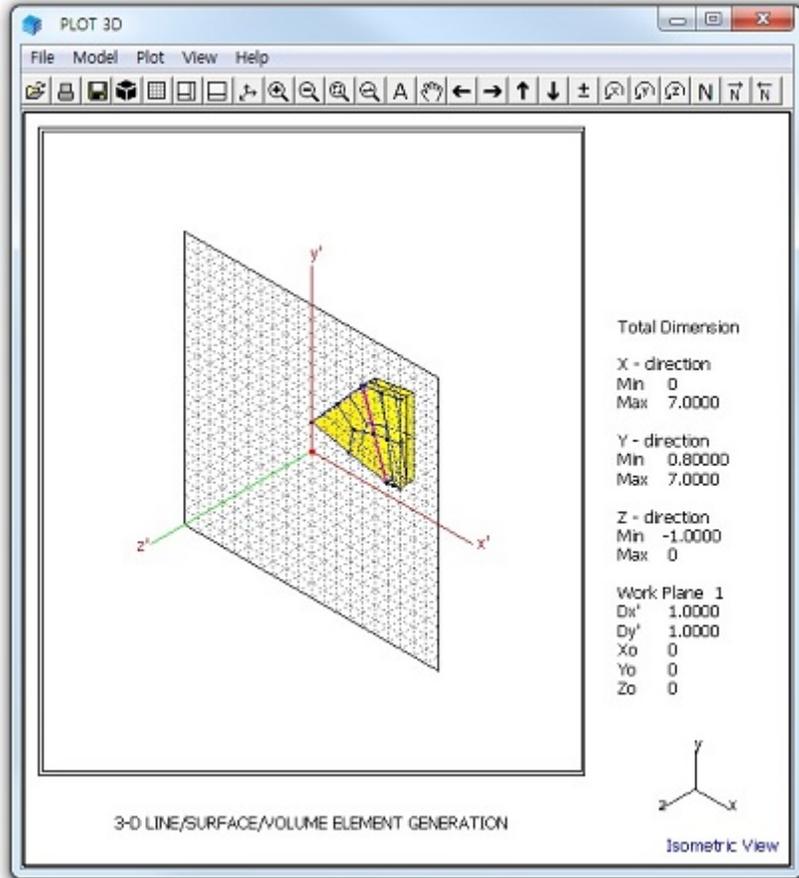


Figure 6.16 Prebuilt work plane: [Isometric \(xy\)](#) View

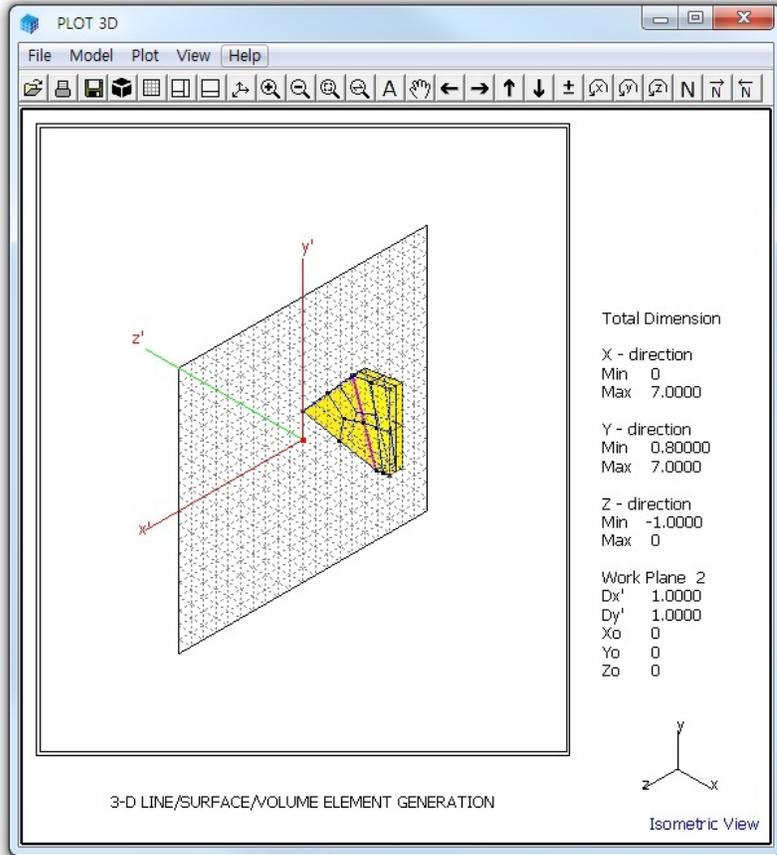


Figure 6.16 Prebuilt work plane: Isometric (zy) View

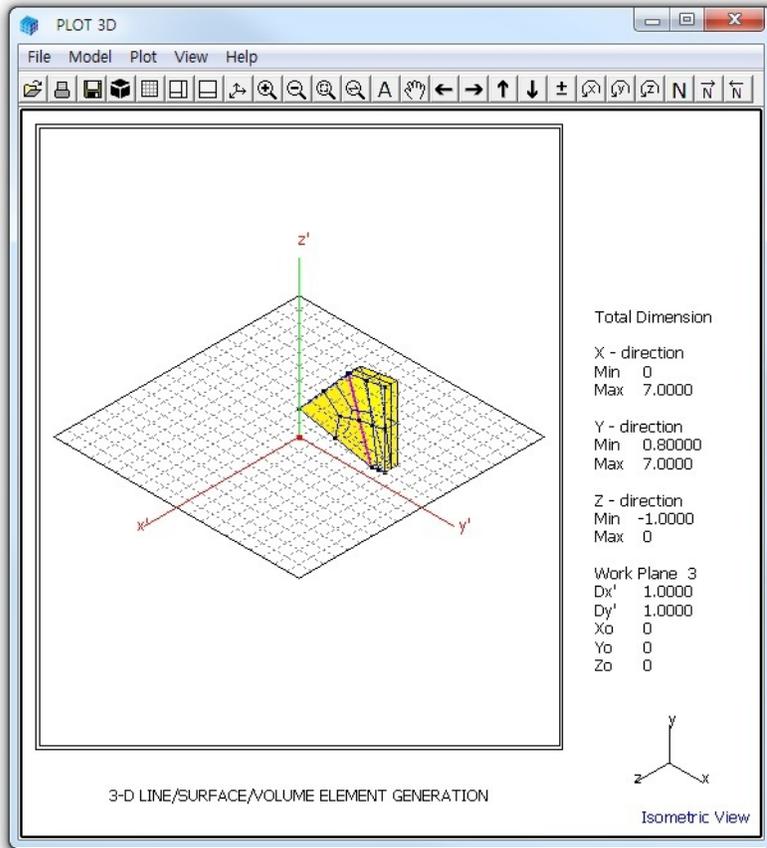


Figure 6.16 Prebuilt work plane: Isometric (zx) View

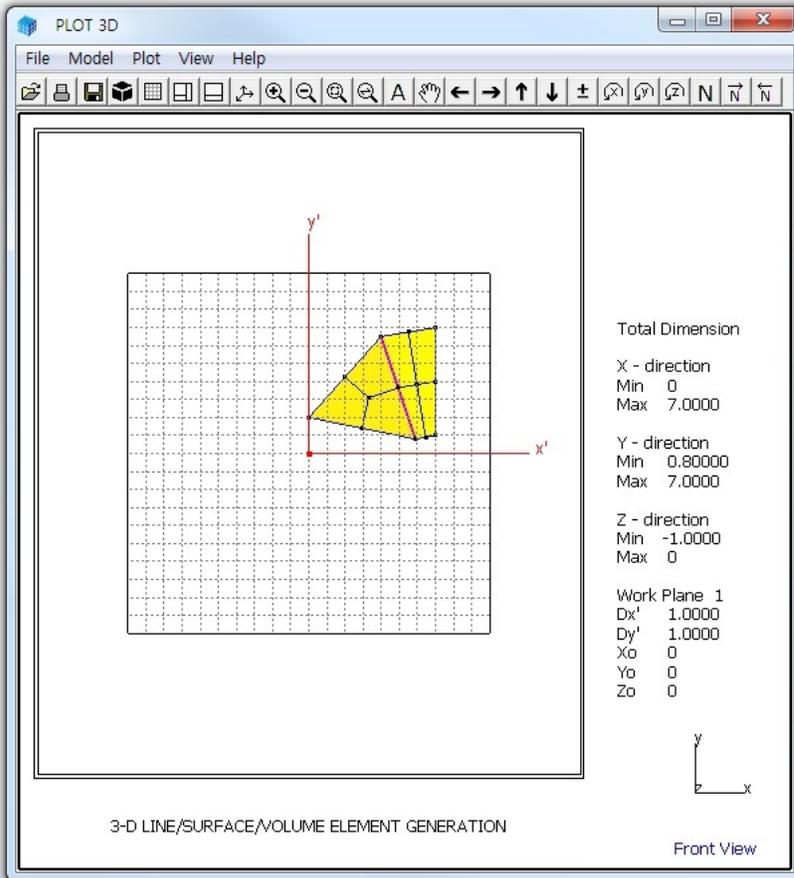


Figure 6.16 Prebuilt work plane: **Front View**

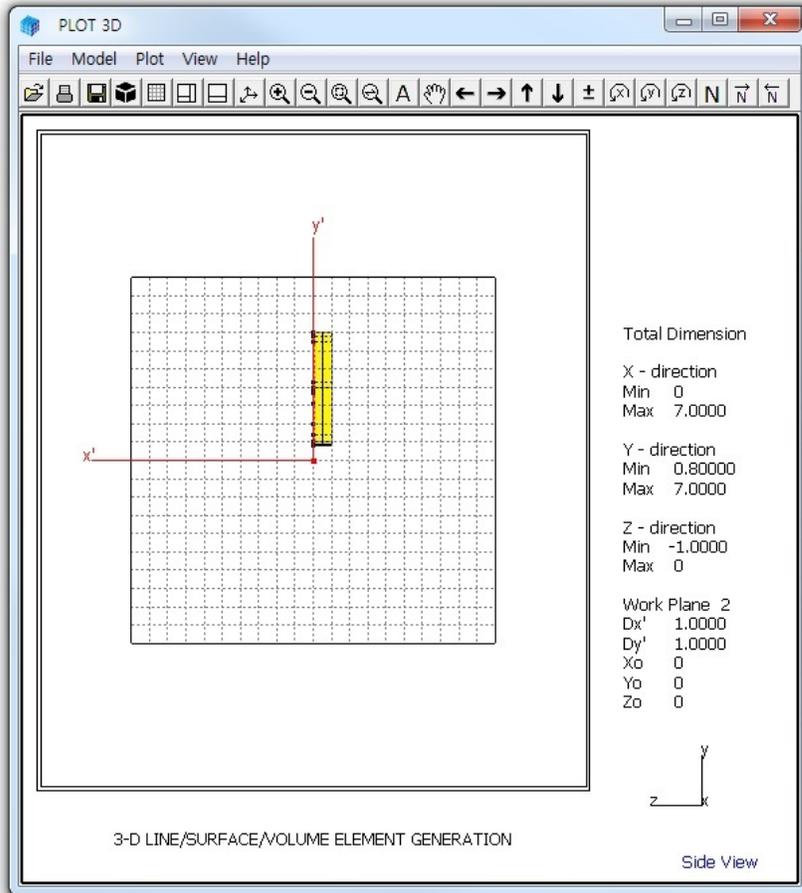


Figure 6.16 Prebuilt work plane: Side View

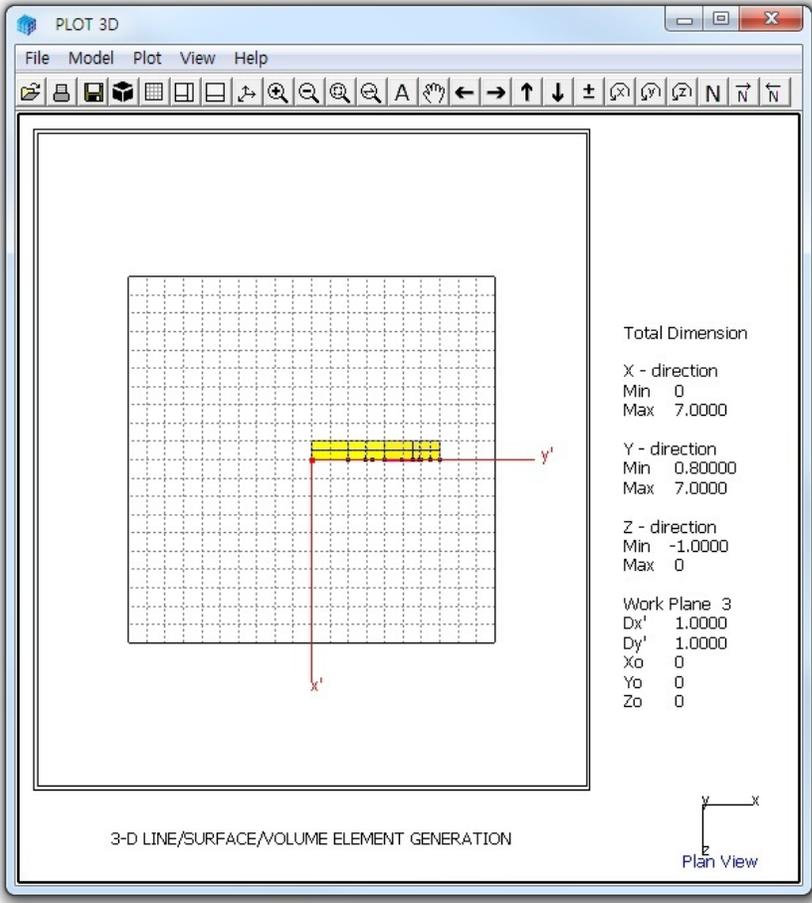


Figure 6.16 Prebuilt work plane: [Plan View](#)

## 6.4 Entities

**Entities** are geometric objects under the work plane, which are mainly used to assist editing geometry of blocks and elements.

There are five types of entities: **Line**, **Arc**, **Cube**, **Ellipsoid**, and **Cylinder**.

**Entity Editor** dialog in Figure 6.17 can be accessed by clicking **Entity** button on the **Work Plane Editor** dialog in Figure 6.8.

**Entity Editor** dialog consists of following seven parts:

- Entity Number
- Line Thickness
- Line Type
- Line Visibility
- Line Color
- Reference Coordinate
- Command Buttons

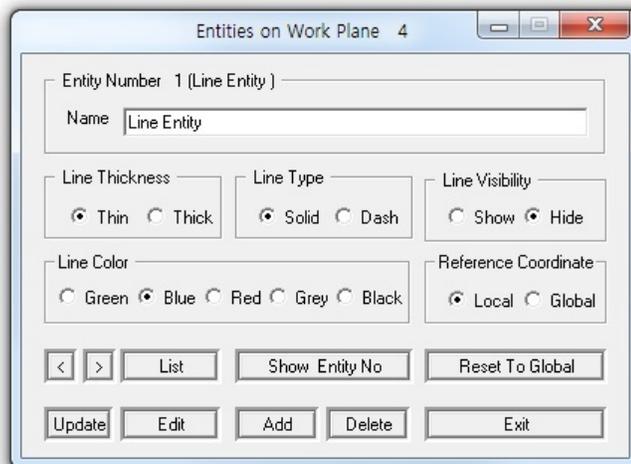


Figure 6.17 Entity editor dialog

### **6.4.1 Entity Number**

Entity number and type are automatically displayed.  
You can edit default entity name.

### **6.4.2 Line Thickness**

Two options are available: [Thin](#) and [Thick](#).

### **6.4.3 Line Type**

Two options are available: [Solid](#) and [Dash](#).

### **6.4.4 Line Visibility**

Two options are available: [Show](#) and [Hide](#).

### **6.4.5 Line Color**

Five options are available: [Green](#), [Blue](#), [Red](#), [Grey](#), and [Black](#).

### **6.4.6 Reference Coordinate**

Two options are available: [Local](#) and [Global](#).

## 6.4.7 Command Buttons

Command buttons are shown on [Entity](#) dialog in Figure 6.17.

### [List](#)

This is used to list all available entities in current work plane.

When you click **OK** button, selected entity will be displayed as the current entity on the [Entity Editor](#) dialog.



Figure 6.18  
Entity list dialog

### [Show Entity No](#)

This is used to show all entity numbers on the screen.

### [Reset To Global](#)

This is used to reset the current entity global reference by the current local coordinate.

### [Update](#)

This is used to update parameters of the current entity.

### [Edit](#)

This is used to edit the geometry of the current entity.

### [Add](#)

This is used to add new entity. Refer to Section 6.4.9

### [Delete](#)

This is used to delete the current entity.

### [Exit](#)

This is used to exit from the [Entity Editor](#) dialog.

### 6.4.8 Popup Menu for Entity

When [Entity Editor](#) dialog is opened, you can directly access an entity by [Control + Right Click](#). Then the selected entity is displayed on the [Entity Editor](#) dialog along with [Popup Menu](#) as shown in Figure 6.19.

[Popup Menu](#) consists of eight submenus:

[Edit](#), [Copy](#), [Add](#), [Hide](#), [Delete](#), [List](#), [Number](#) and [Exit](#).

These menus are essentially duplicates of command buttons on the [Entity Editor](#) dialog.



Figure 6.19 Popup menu for entity

### 6.4.9 Adding New Entity

To add a new entity, click **Add** button on **Entity Editor** dialog. Then **Entity Type Selection** dialog will be displayed as shown in Figure 6.20.

There are five types of entities: **Line**, **Arc**, **Cube**, **Ellipsoid** and **Cylinder**. You can also select **Copy Existing Entity** and then type **Entity No.**

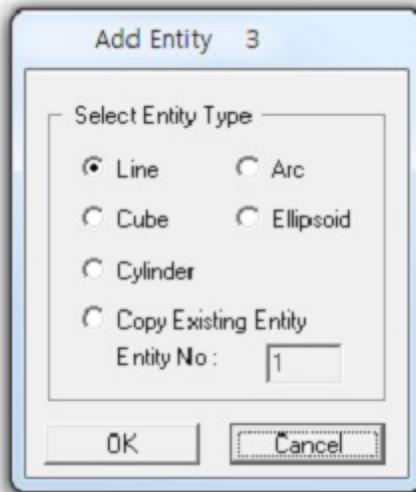


Figure 6.20 Entity type selection dialog

### 6.4.9.1 Line Entity

Line Entity dialog is shown in Figure 6.21.

To draw Line Entity, follow five steps:

1. Enter Point Number
2. Select Reference
3. Select Method
4. Enter Coordinate
5. Draw Point Number

For Mouse Pickup method, when clicking Draw Point Number button at step 5, Coordinates on Work Plane dialog in Figure 6.22 will be opened. Click Info button to see the notes on Mouse Actions on Work Plane as shown in Figure 6.23. Once finished, click Finish in Figure 6.22.

Finally, click Finish on Line Entity dialog in Figure 6.21.

Then you will be back to Entity Editor dialog where you can set the other parameters for the new entity.

Figure 6.21  
Line entity dialog

Entity 7 on Work Plane 4

1. Enter Point Number  
1  
For New Drawing, 0

2. Select Reference  
Local

3. Select Method  
 Mouse Pickup  
 Enter  $x'$ ,  $y'$ ,  $z'$

4. Enter Coordinate  
 $x'$  = 0  
 $y'$  = 0  
 $z'$  = 0  
 Shift All Points

5. Draw Point Number

Finish Cancel

Enter point number 0 to redraw entity.  
Local coordinates depend on current work plane.  
Repeat Step 1 through 5 for each point number.  
Click Finish button once you finished all points.

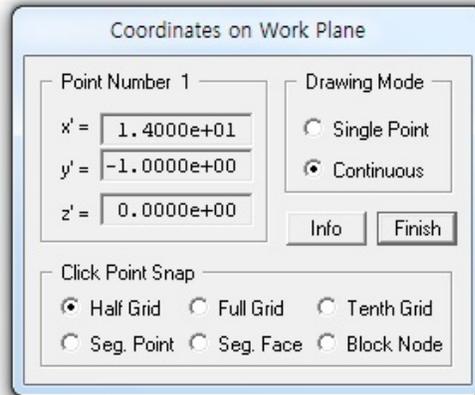


Figure 6.22 Coordinates on work plane

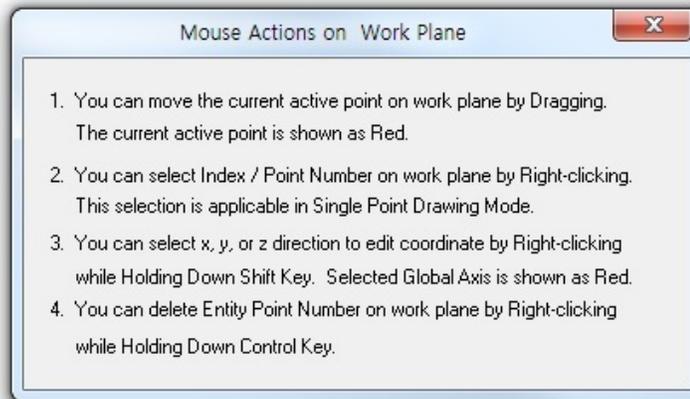


Figure 6.23 Mouse actions on work plane

### 6.4.9.2 Arc Entity

Arc Entity dialog is shown in Figure 6.24.

To draw Arc Entity, follow five steps:

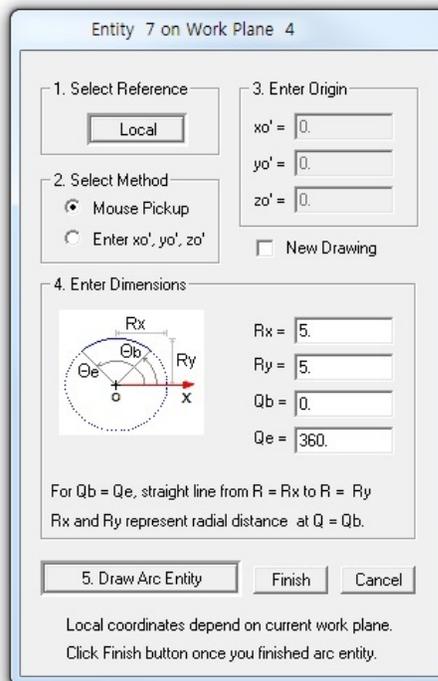
1. Select Reference
2. Select Method
3. Enter Origin
4. Enter Dimensions
5. Draw Arc Entity

For Mouse Pickup method, when clicking Draw Arc Entity button at step 5, Coordinates on Work Plane dialog in Figure 6.22 will be opened.

Click Info button to see the notes on Mouse Actions on Work Plane as shown in Figure 6.23. Once finished, click Finish in Figure 6.22.

Finally, click Finish on Arc Entity dialog in Figure 6.24.

Then you will be back to Entity Editor dialog where you can set the other parameters for the new entity.



Entity 7 on Work Plane 4

1. Select Reference  
Local

2. Select Method  
 Mouse Pickup  
 Enter xo', yo', zo'

3. Enter Origin  
 xo' = 0.  
 yo' = 0.  
 zo' = 0.  
 New Drawing

4. Enter Dimensions

Rx = 5.  
 Ry = 5.  
 Qb = 0.  
 Qe = 360.

For Qb = Qe, straight line from R = Rx to R = Ry  
 Rx and Ry represent radial distance at Q = Qb.

5. Draw Arc Entity    Finish    Cancel

Local coordinates depend on current work plane.  
 Click Finish button once you finished arc entity.

Figure 6.24  
Arc entity dialog

### 6.4.9.3 Cube Entity

Cube Entity dialog is shown in Figure 6.25.

To draw Cube Entity, follow five steps:

1. Select Reference
2. Select Method
3. Enter Origin
4. Enter Dimensions
5. Draw Cube Entity

For Mouse Pickup method, when clicking Draw Cube Entity button at step 5, Coordinates on Work Plane dialog in Figure 6.22 will be opened.

Click Info button to see the notes on Mouse Actions on Work Plane as shown in Figure 6.23. Once finished, click Finish in Figure 6.22.

Finally, click Finish on Cube Entity dialog in Figure 6.25.

Then you will be back to Entity Editor dialog where you can set the other parameters for the new entity.

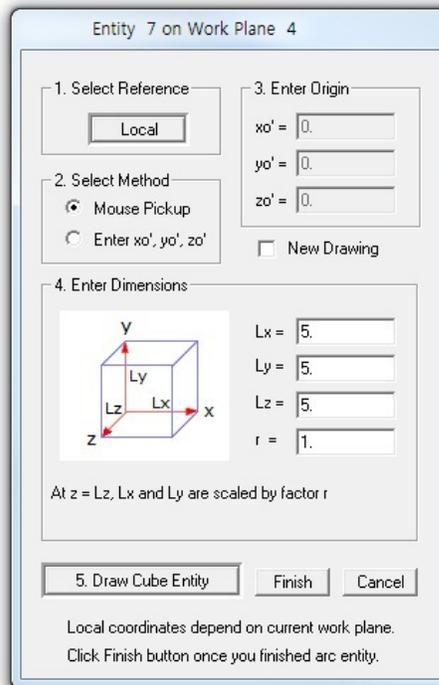


Figure 6.25  
Cube entity dialog

### 6.4.9.4 Ellipsoid Entity

Ellipsoid Entity dialog is shown in Figure 6.26.

To draw Ellipsoid Entity, follow five steps:

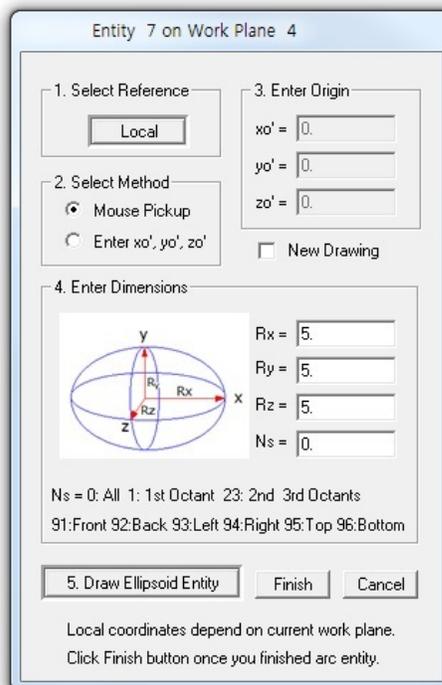
1. Select Reference
2. Select Method
3. Enter Origin
4. Enter Dimensions
5. Draw Ellipsoid Entity

For Mouse Pickup method, when clicking Draw Ellipsoid Entity button at step 5, Coordinates on Work Plane dialog in Figure 6.22 will be opened. Click Info button to see the notes on Mouse Actions on Work Plane as in Figure 6.23. Once finished, click Finish in Figure 6.22.

Finally, click Finish on Ellipsoid Entity dialog in Figure 6.26.

Then you will be back to Entity Editor dialog where you can set the other parameters for the new entity.

Figure 6.26  
Ellipsoid entity dialog



### 6.4.9.5 Cylinder Entity

Cylinder Entity dialog is shown in Figure 6.27.

To draw Cylinder Entity, follow five steps:

1. Select Reference
2. Select Method
3. Enter Origin
4. Enter Dimensions
5. Draw Cylinder Entity

For Mouse Pickup method, when clicking Draw Cylinder Entity button at step 5, Coordinates on Work Plane dialog in Figure 6.22 will be opened. Click Info button to see the notes on Mouse Actions on Work Plane as in Figure 6.23. Once finished, click Finish in Figure 6.22.

Finally, click Finish on Cylinder Entity dialog in Figure 6.27.

Then you will be back to Entity Editor dialog where you can set the other parameters for the new entity.

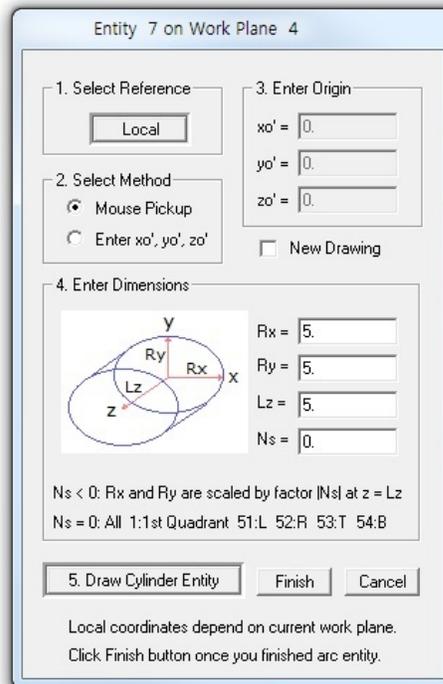


Figure 6.27  
Cylinder entity dialog

## 6.5 Block

**Blocks** are groups of elements. Each block consist of the same type of finite elements.

**Block Editor** can be accessed by selecting the following menu items in **PLOT-3D**:

**Model** → **Block Editor**

or by clicking **Block Editor** toolbar as shown in Figure 6.28.

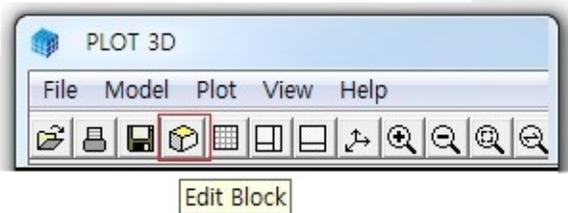


Figure 6.28 Block editor toolbar

**Block Editor** dialog in Figure 6.29 consists of following eight parts:

- Title
- Block Number
- Interpolation Coordinate System
- Coordinate Modification
- Interpolation Scheme / Element Type
- Reference Node Numbers
- Material and Element Generation Parameters
- Command Buttons

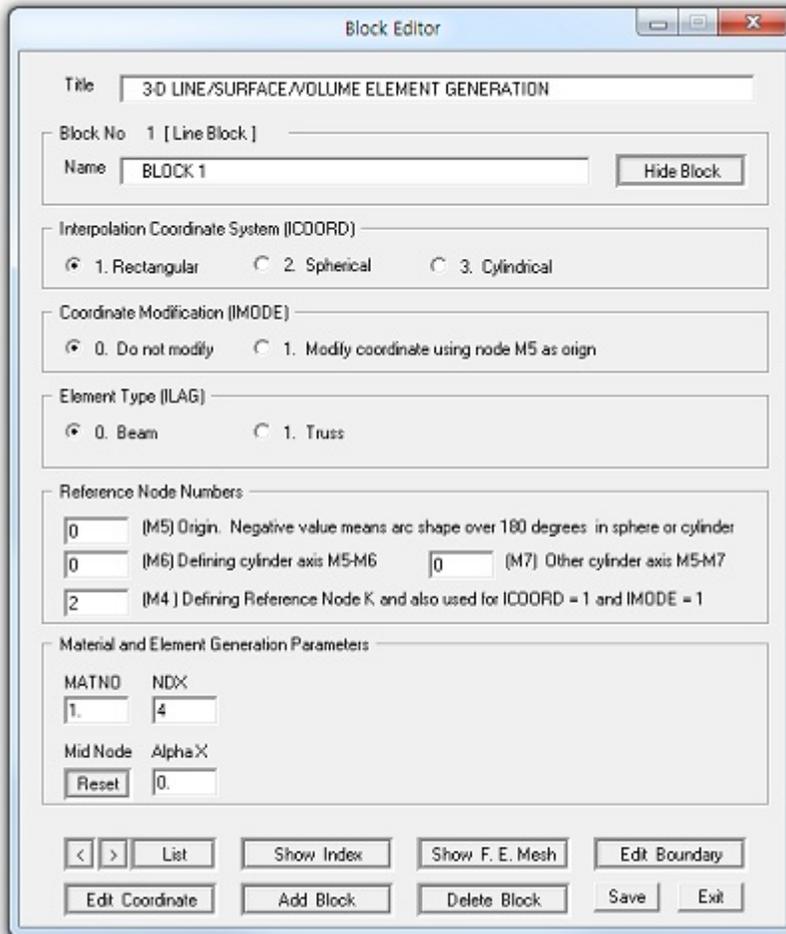


Figure 6.29 Block editor (Line Block)

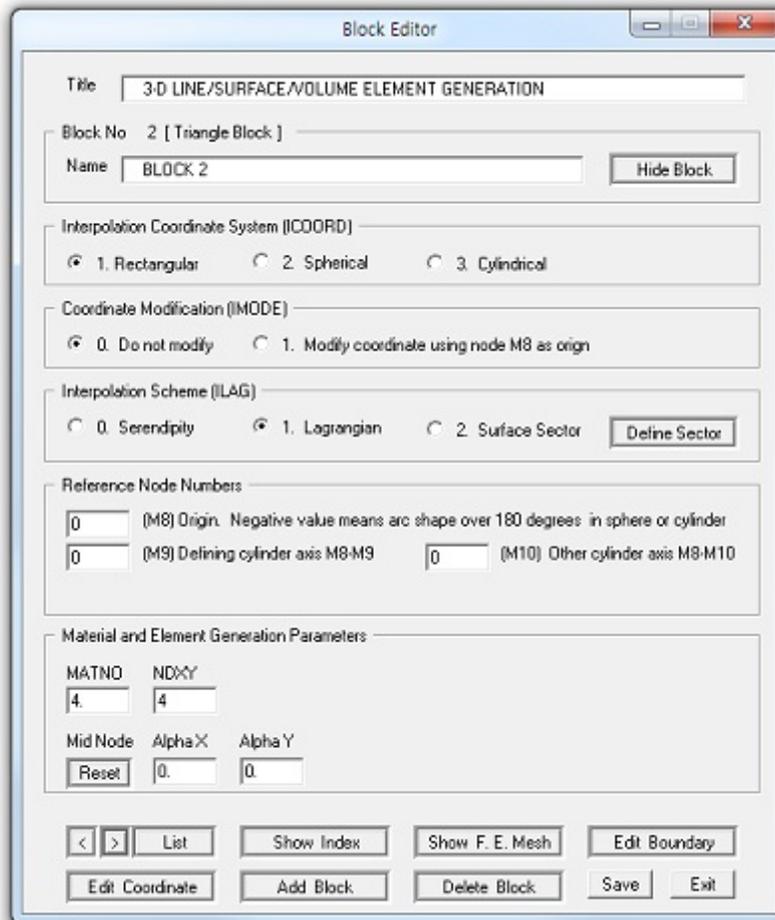


Figure 6.29 Block editor (Triangle Block)

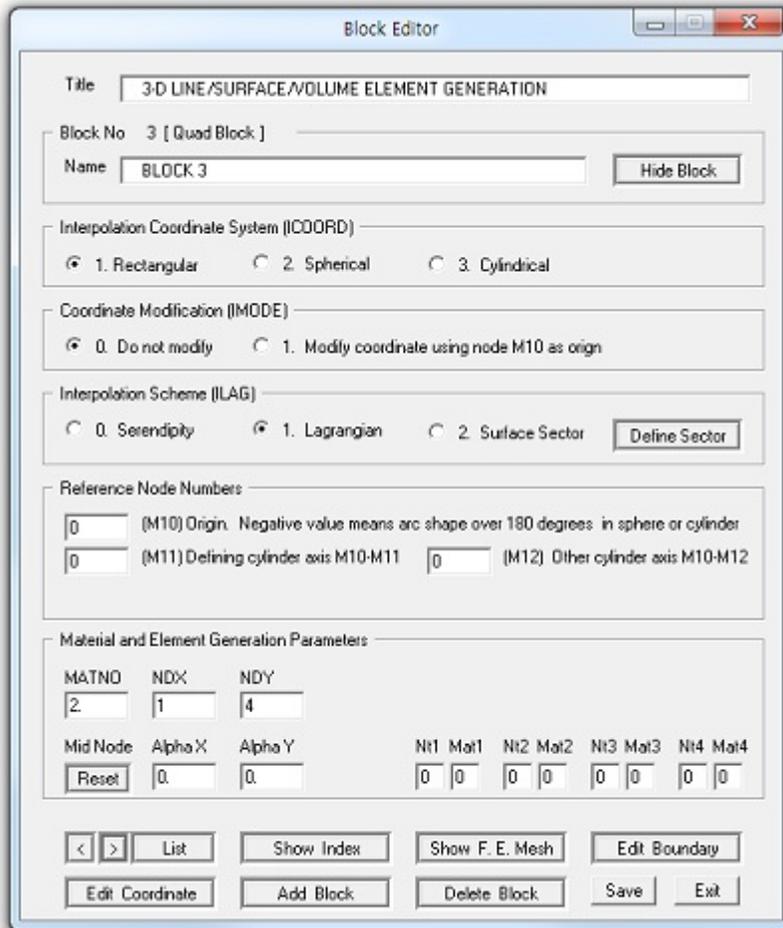
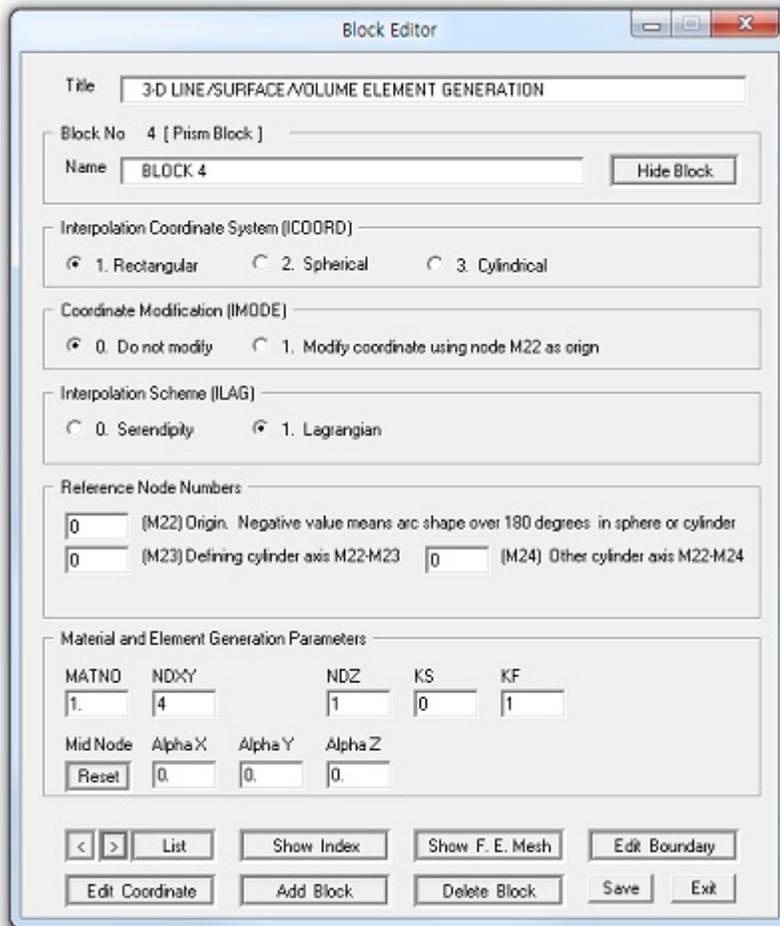


Figure 6.29 Block editor (Quad Block)

Figure 6.29 Block editor ([Prism Block](#))

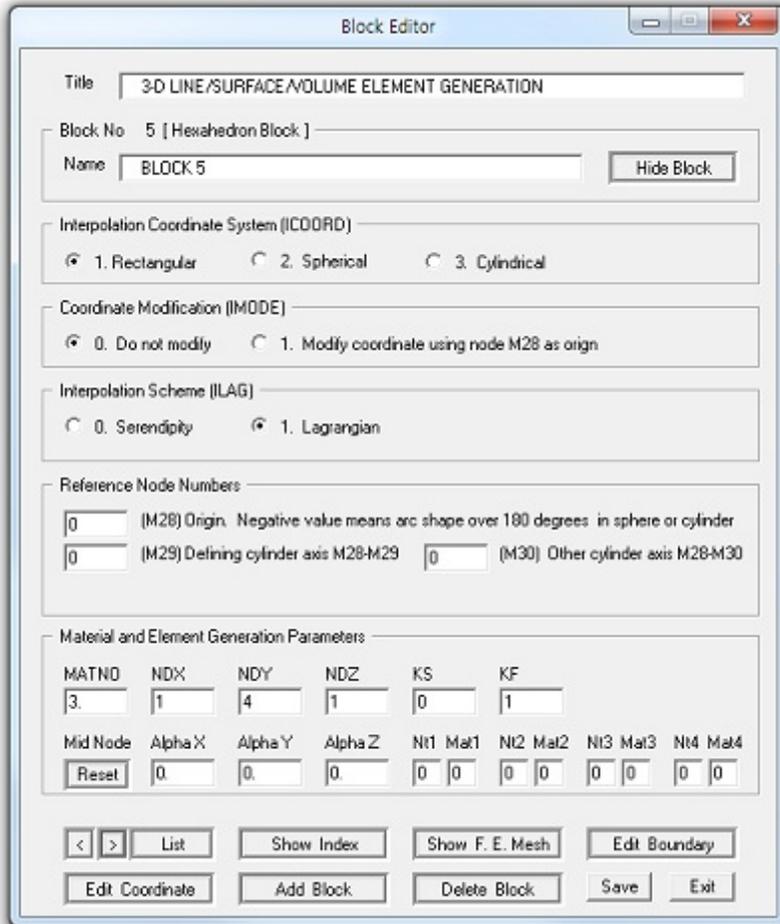


Figure 6.29 Block editor (Hexahedron Block)

### **6.5.1 Title**

This is the title for the block mesh file.

### **6.5.2 Block Number**

Block number and type are automatically displayed as the label of the frame. You can specify block name for identification.

[Hide Block](#) button is to hide the current block on the screen.

### **6.5.3 Interpolation Coordinate System**

This is to select the coordinate system for interpolation.

Three options are available: [Rectangular](#), [Spherical](#) and [Cylindrical](#).

### **6.5.4 Coordinate Modification**

This is to modify generated coordinates based on the reference node as origin.

### **6.5.5 Interpolation Scheme / Element Type**

For line blocks, two options are available for the type of line element: [Beam](#) and [Truss](#).

For surface blocks, three options are available: [Serendipity](#), [Lagrangian](#) and [Surface Sector](#).

For volume blocks, two options are available: [Serendipity](#) and [Lagrangian](#).

When you click [Define Sector](#) button, [Surface Sector](#) dialog is displayed to edit input parameters as shown in Figure 6.30.

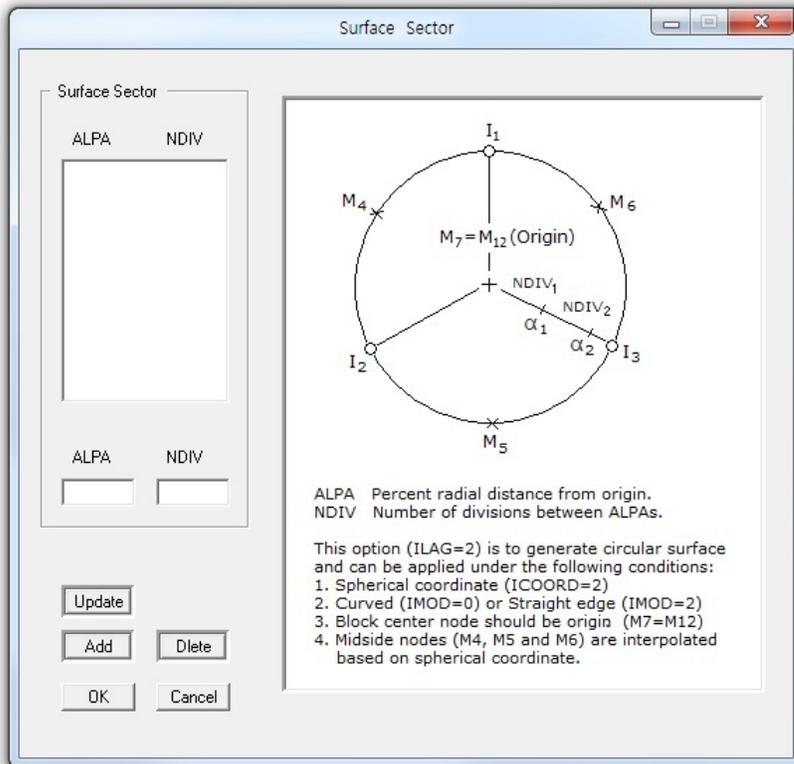


Figure 6.30 Surface sector (Triangle Block)

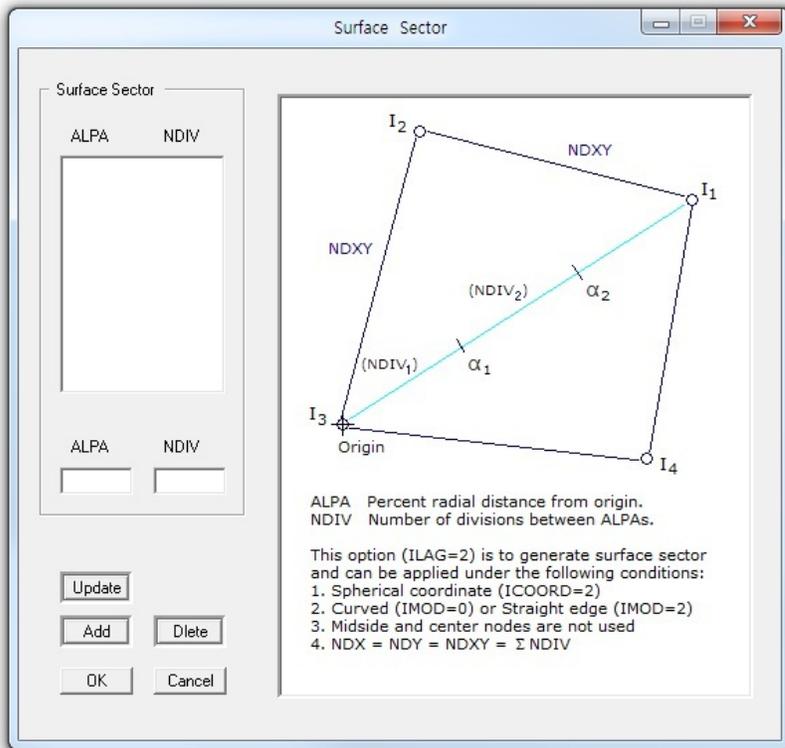


Figure 6.30 Surface sector (Quad Block)

### 6.5.6 Reference Node Numbers

This is to specify reference node numbers which are associated with block type.

### 6.5.7 Material & Element Generation Parameters

This is to specify material number and element generation parameters for the block.

### 6.5.8 Command Buttons

Command buttons are shown on the bottom of [Block Editor](#) dialog in Figure 6.29.

#### [List](#)

This is used to list all available blocks in the current block mesh as shown in Figure 6.31.

When you click **OK** button, selected block will be displayed as the current block on the [Block Editor](#) dialog.

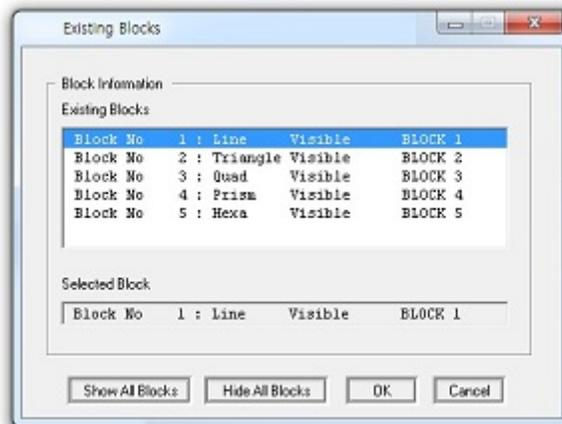


Figure 6.31 Block list

#### [Show Index](#)

This is used to show block index numbers.

#### [Show F. E. Mesh](#)

This is used to execute block mesh and then plot the generated finite element mesh.

[Edit Boundary](#)

This is used to edit boundary conditions shown in Figure 6.32.

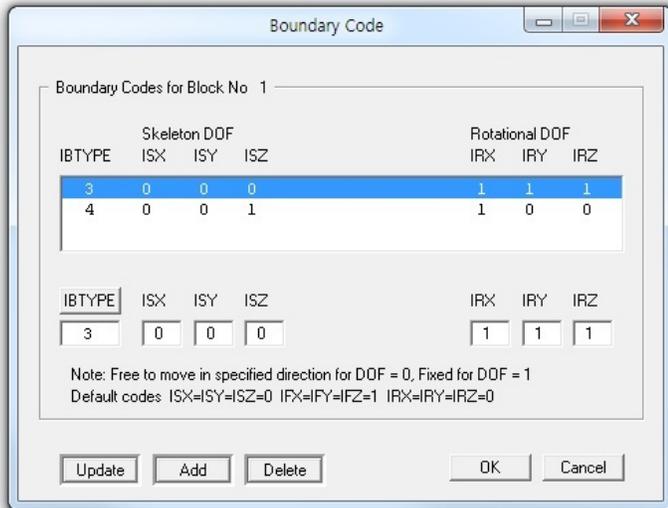
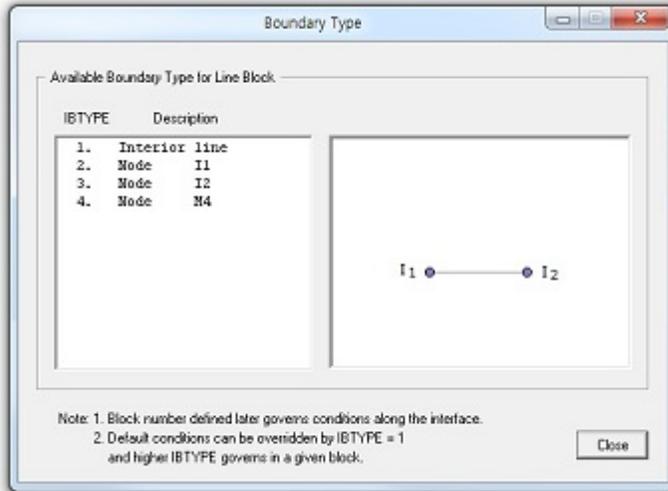


Figure 6.32 Boundary code (Line Block)

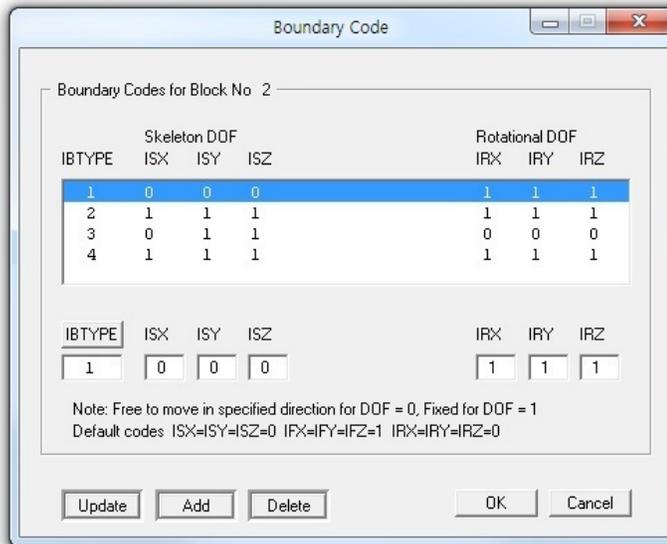
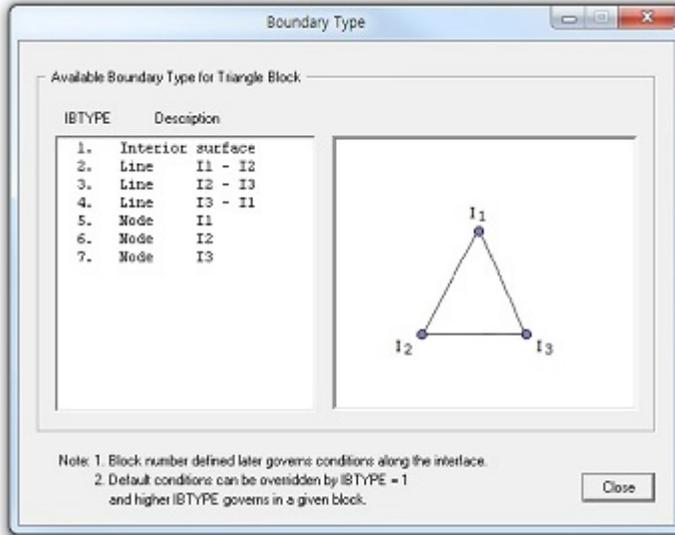


Figure 6.32 Boundary code (Triangle Block)

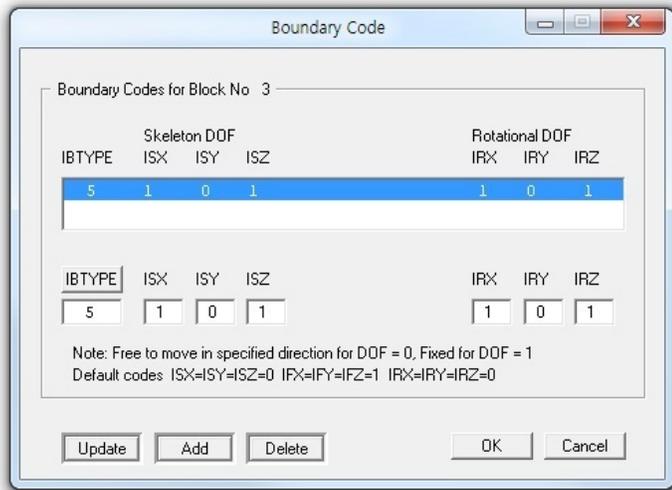
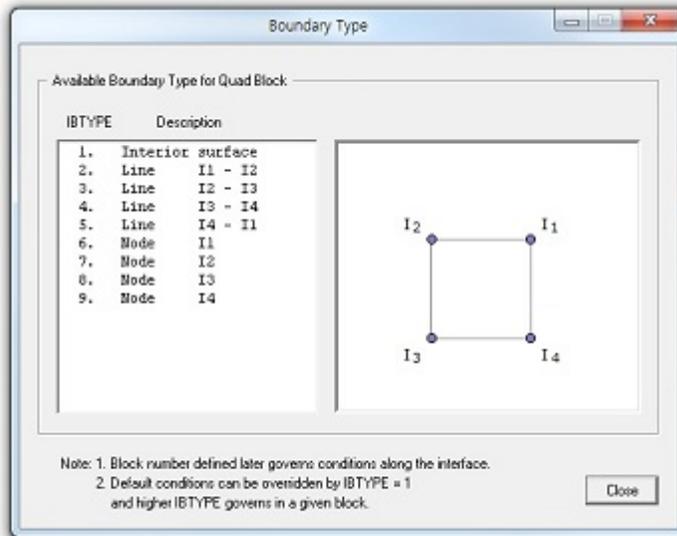


Figure 6.32 Boundary code (Quad Block)

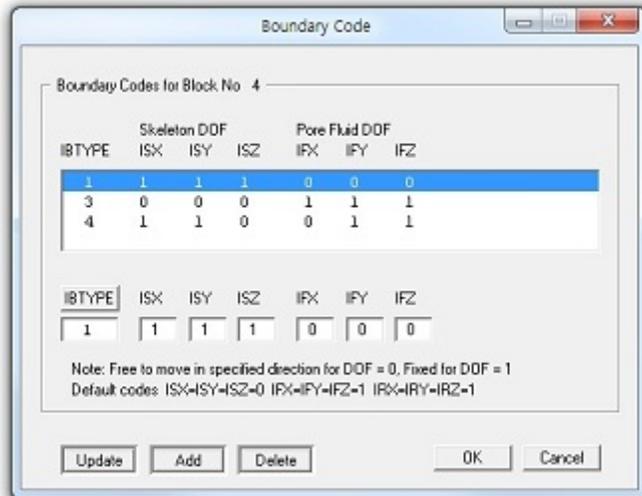
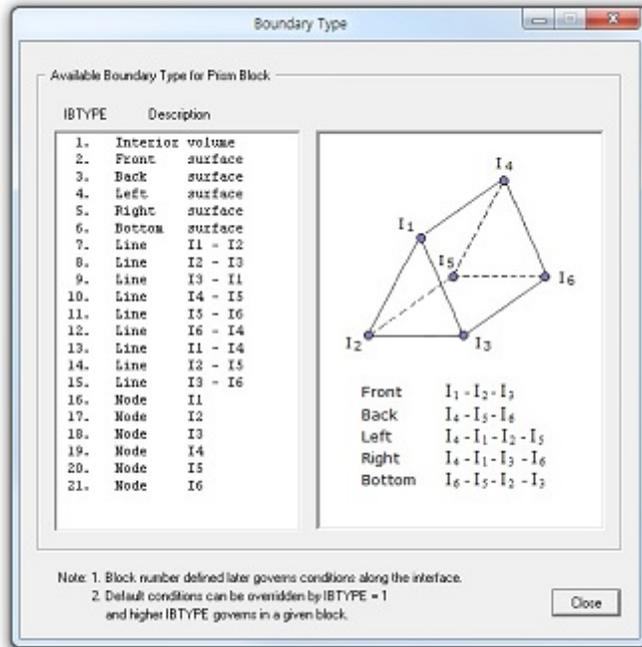


Figure 6.32 Boundary code (Prism Block)

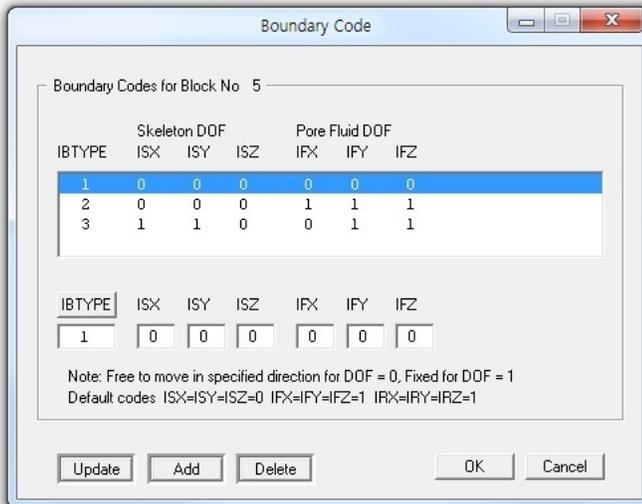
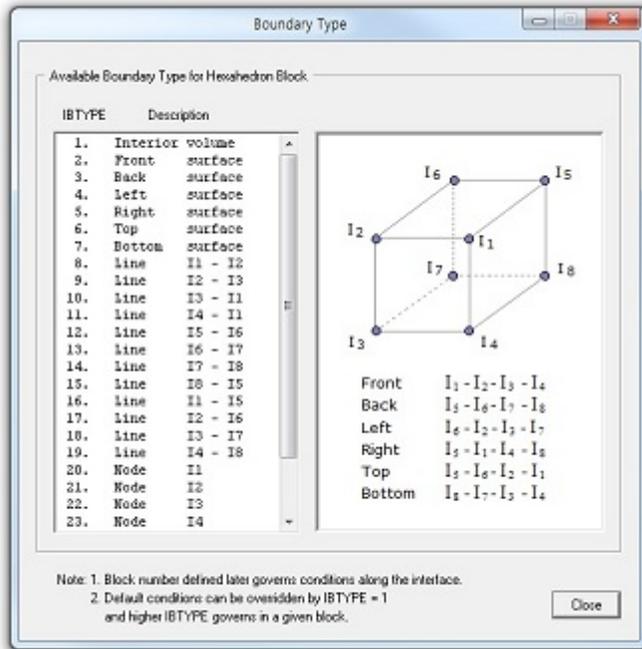


Figure 6.32 Boundary code (Hexahedron Block)

Edit Coordinate

This is used to edit the geometry of the block.  
Before editing, work plane should be displayed on the screen.

Type **Block No** on **Edit Current Block** dialog in Figure 6.33  
and then click **OK** button.

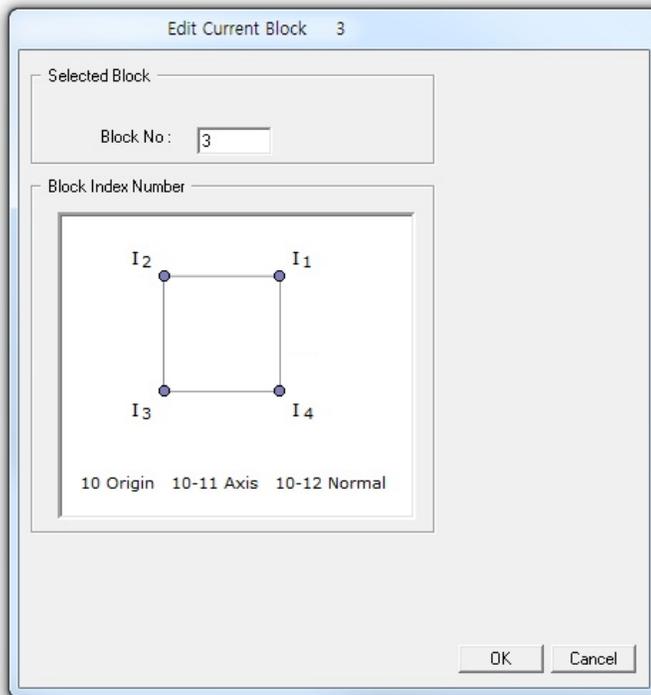


Figure 6.33 Edit current block (Selection Mode)

**Edit Current Block** dialog now shows input parameters required to edit the geometry of the block as shown in Figure 6.34.

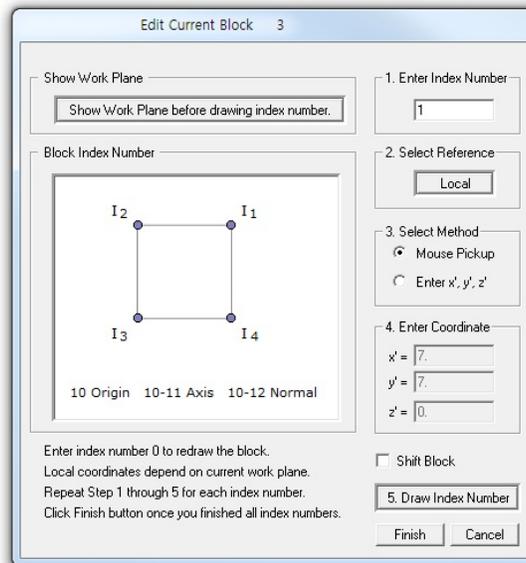
To edit block, follow five steps:

1. Enter Index Number
2. Select Reference
3. Select Method
4. Enter Coordinate
5. Draw Index Number

For **Mouse Pickup** method, when clicking **Draw Index Number** button at step 5, **Coordinates on Work Plane** dialog in Figure 6.35 will be opened. Click **Info** button to see the notes on **Mouse Actions on Work Plane** as shown in Figure 6.36. Once finished, click **Finish** in Figure 6.35.

Finally, click **Finish** on **Edit Current Block** dialog in Figure 6.34. Then you will be back to **Block Editor** dialog where you can set the other parameters for the current block.

Figure 6.34  
Edit current block  
(Edit Mode)



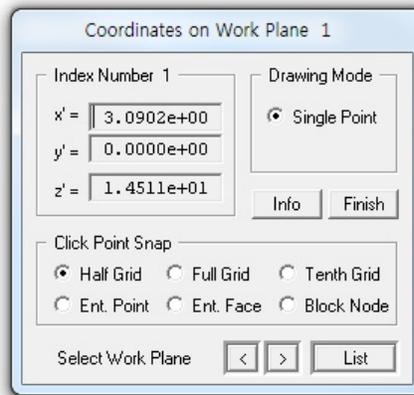


Figure 6.35 Coordinates on work plane

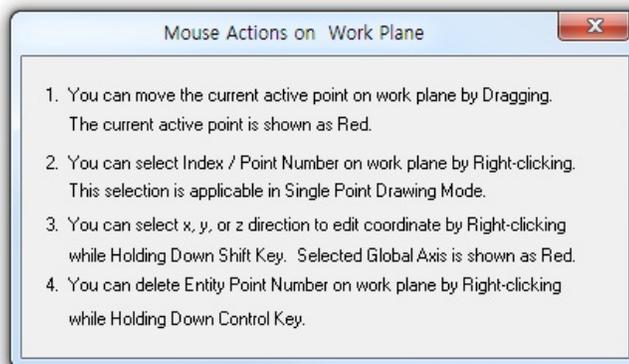


Figure 6.36 Mouse actions on work plane

### [Add Block](#)

This is used to add the geometry of the new block.  
Before building, work plane should be displayed on the screen.

**Build New Block** dialog in Figure 6.37 will be displayed.  
Select **Block Type**, **Interpolation Coordinate System**  
and then click **OK** button.

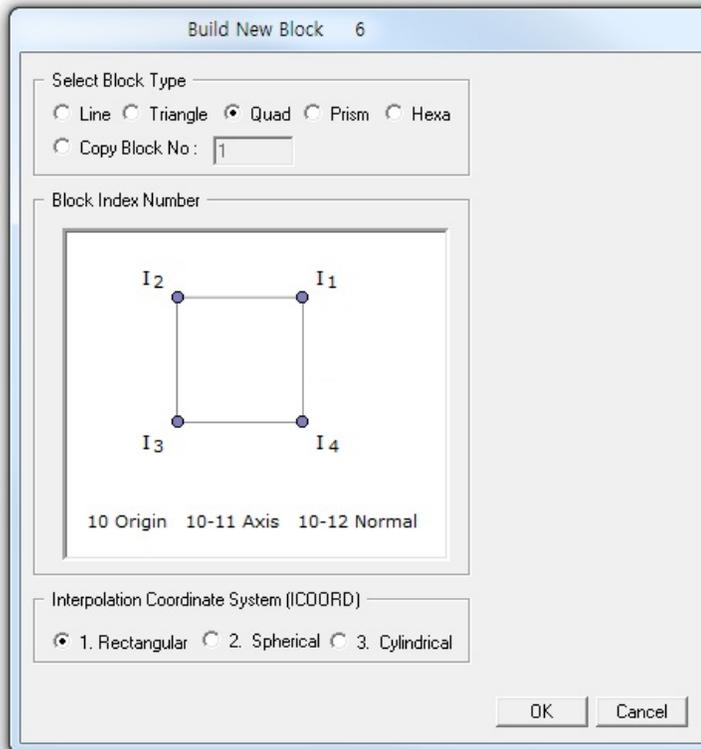


Figure 6.37 Build new block ([Selection Mode](#))

**Build New Block** dialog now shows input parameters required to build the geometry of new block as shown in Figure 6.38.

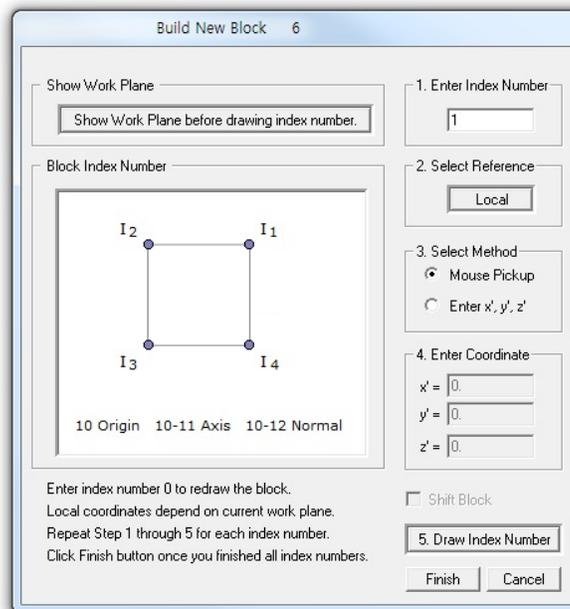
To build new block, follow five steps:

1. Enter Index Number
2. Select Reference
3. Select Method
4. Enter Coordinate
5. Draw Index Number

For **Mouse Pickup** method, when clicking **Draw Index Number** button at step 5, **Coordinates on Work Plane** dialog in Figure 6.39 will be opened. Click **Info** button to see the notes on **Mouse Actions on Work Plane** as shown in Figure 6.36. Once finished, click **Finish** in Figure 6.39.

Finally, click **Finish** on **Build New Block** dialog in Figure 6.38. Then you will be back to **Block Editor** dialog where you can set the other parameters for the new block.

Figure 6.38  
Build new block  
(Build Mode)



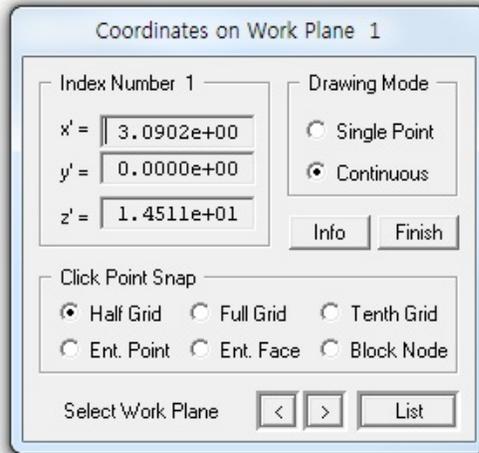


Figure 6.39 Coordinates on work plane

#### [Delete Block](#)

This is used to delete the current block.

#### [Save](#)

This is used to save all the works you have done.

#### [Exit](#)

This is used to exit from the block editor.

### 6.5.9 Popup Menu for Block

When [Block Editor](#) dialog is opened, you can directly access a block by [Shift + Right Click](#). Then the selected block is displayed on the [Block Editor](#) dialog along with [Popup Menu](#) as shown in Figure 6.40.

[Popup Menu](#) consists of eleven submenus:

[Edit](#), [Copy](#), [Add](#), [Hide](#), [Delete](#), [List](#), [Index](#), [Boundary](#), [F.E. Mesh](#), [Save](#) and [Exit](#). These menus are essentially duplicates of command buttons on the [Block Editor](#) dialog.



Figure 6.40 Popup menu for block

## 6.6 Modifying Finite Element Meshes

**Block Mesh Generator** can be used to directly modify finite element mesh.

When you open input file, **Mesh Generator** reads the format of the input file and automatically identifies whether it is block mesh file or finite element mesh file.

Editing finite element mesh has three parts: **Edit Element**, **Edit Node** and **Edit Title**. These editing modes can be accessed from **Model** menu in **PLOT-3D** as shown in Figure 6.41.

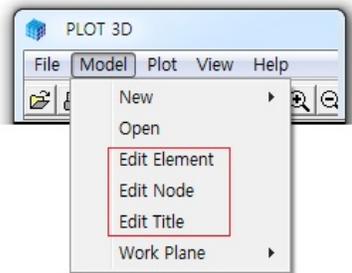


Figure 6.41 Menu for editing finite element mesh

You can check the current editing mode by moving the mouse on **Editing Mode** toolbar as shown in Figure 6.42.

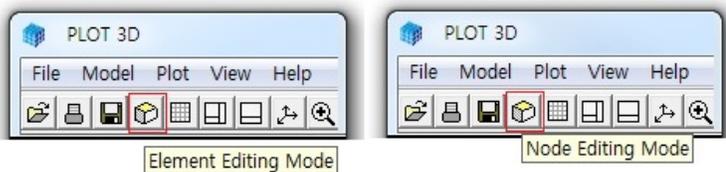
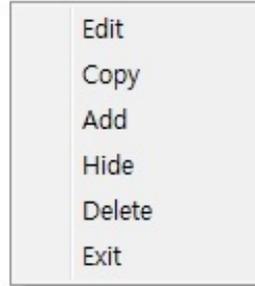


Figure 6.42 Toolbar for editing finite element mesh

### 6.6.1 Edit Element

When you are in [Element Editing Mode](#), you can access popup menu for element in Figure 6.43 by [Shift + Right Click](#).

Figure 6.43 Popup menu for element



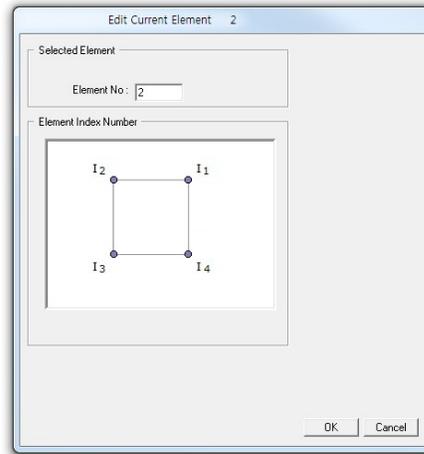
Element popup menu consists of six submenus: [Edit](#), [Copy](#), [Add](#), [Hide](#), [Delete](#) and [Exit](#).

#### [Edit](#)

This is used to edit the geometry of element.  
Before editing, work plane should be displayed on the screen.

[Edit Current Element](#) dialog is displayed in Figure 6.44.  
Type [Element No](#) and click [OK](#) button.

Figure 6.44  
Edit current element  
([Selection Mode](#))



**Edit Current Element** dialog now shows input parameters required to edit the geometry of element as shown in Figure 6.45.

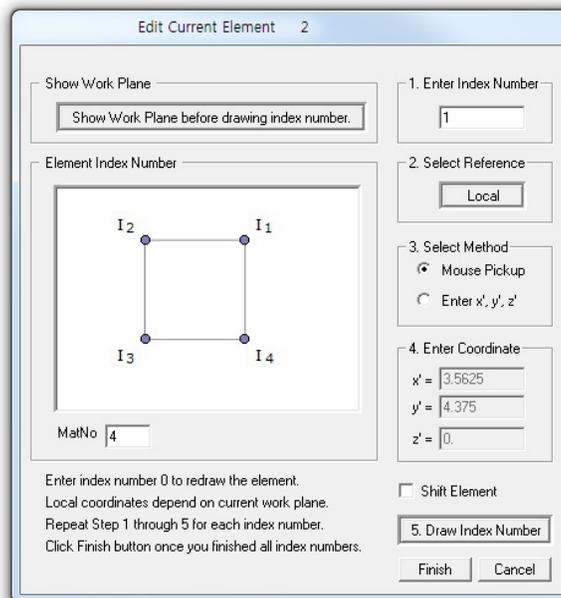
To edit element, follow five steps:

1. Enter Index Number
2. Select Reference
3. Select Method
4. Enter Coordinate
5. Draw Index Number

For **Mouse Pickup** method, when clicking **Draw Index Number** button at step 5, **Coordinates on Work Plane** dialog in Figure 6.46 will be opened. Click **Info** button to see the notes on **Mouse Actions on Work Plane** as shown in Figure 6.47. Once finished, click **Finish** in Figure 6.46.

Finally, click **Finish** on **Edit Current Element** dialog in Figure 6.45.

Figure 6.45  
Edit current element  
(Edit Mode)



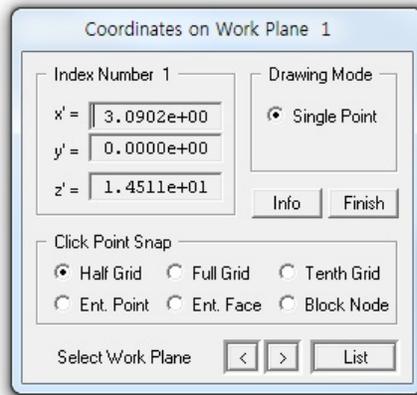


Figure 6.46 Coordinates on work plane ([Edit Mode](#))

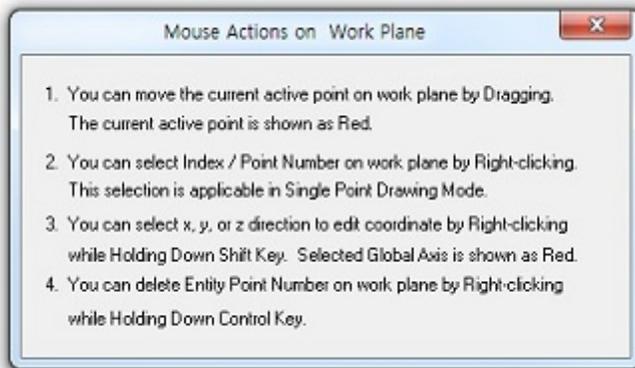


Figure 6.47 Mouse actions on work plane

**Copy**

This is used to copy the selected element and paste it as new element.

**Edit Current Element** dialog with new element number is displayed as shown in Figure 6.48. **Shift Element** check box should be checked to move this new element.

Follow the same procedure as in [Edit](#).

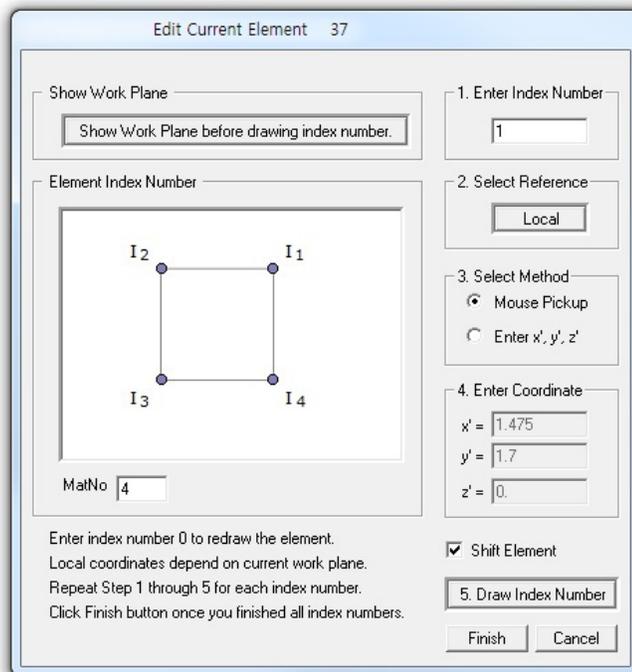


Figure 6.48 Edit current element (**Copy Mode**)

[Add](#)

This is used to add the geometry of the new element.  
Before building, work plane should be displayed on the screen.

[Build New Element](#) dialog in Figure 6.49 will be displayed.  
Select [Element Type](#) and then click [OK](#) button.

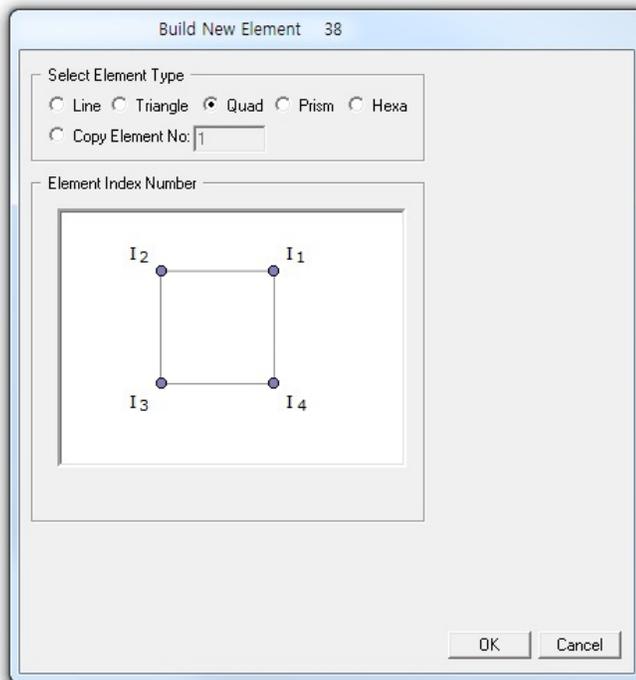


Figure 6.49 Build new element ([Selection Mode](#))

**Build New Element** dialog now shows input parameters required to build the geometry of new element as shown in Figure 6.50.

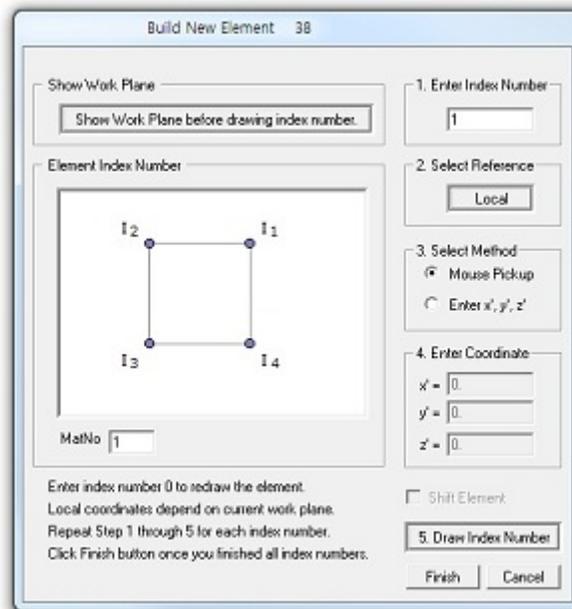
To build new element, follow five steps:

1. Enter Index Number
2. Select Reference
3. Select Method
4. Enter Coordinate
5. Draw Index Number

For **Mouse Pickup** method, when clicking **Draw Index Number** button at step 5, **Coordinates on Work Plane** dialog in Figure 6.51 will be opened. Click **Info** button to see the notes on **Mouse Actions on Work Plane** as shown in Figure 6.47. Once finished, click **Finish** in Figure 6.51.

Finally, click **Finish** on **Build New Element** dialog in Figure 6.50.

Figure 6.50  
Build new element  
(Edit Mode)



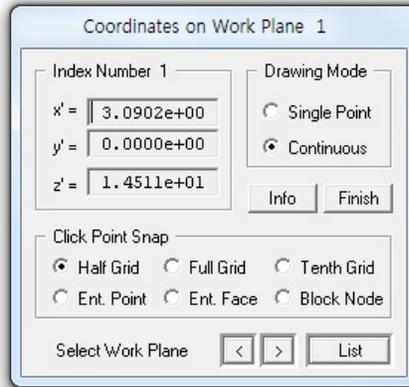


Figure 6.51 Coordinates on work plane ([Add Mode](#))

[Hide](#)

This is used to hide the selected element from the screen.  
To show the hidden element, follow instructions in Figure 6.52.

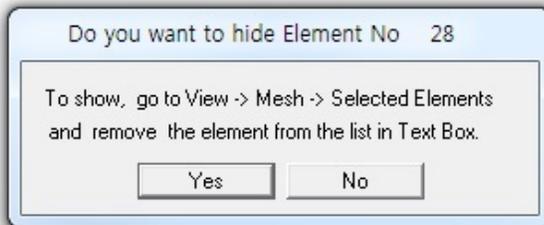


Figure 6.52 Instructions to show the hidden element

[Delete](#)

This is used to delete the selected element.

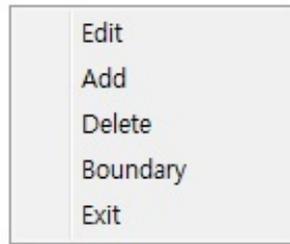
[Exit](#)

This is used to exit from the element editing mode.

## 6.6.2 Edit Node

When you are in [Node Editing Mode](#), you can access popup menu for node in Figure 6.53 by [Shift + Right Click](#).

Figure 6.53 Popup menu for node



Node popup menu consists of five submenus:

[Edit](#), [Add](#), [Delete](#), [Boundary](#) and [Exit](#).

### [Edit](#)

This is used to edit the coordinates of node.

Before editing, work plane should be displayed on the screen.

[Edit Current Node](#) dialog is displayed in Figure 6.54.

To edit current node, follow five steps:

1. Enter Node Number
2. Select Reference
3. Select Method
4. Enter Coordinate
5. Draw Node Number

For [Mouse Pickup](#) method, when clicking [Draw Node Number](#) button at step 5, [Coordinates on Work Plane](#) dialog in Figure 6.55 will be opened.

Click [Info](#) button to see the notes on [Mouse Actions on Work Plane](#) as shown in Figure 6.47. Once finished, click [Finish](#) in Figure 6.55.

Finally, click [Finish](#) on [Edit Current Node](#) dialog in Figure 6.54.

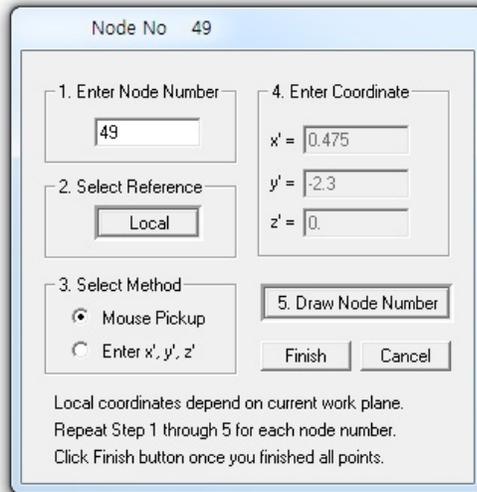


Figure 6.54 Edit current node dialog

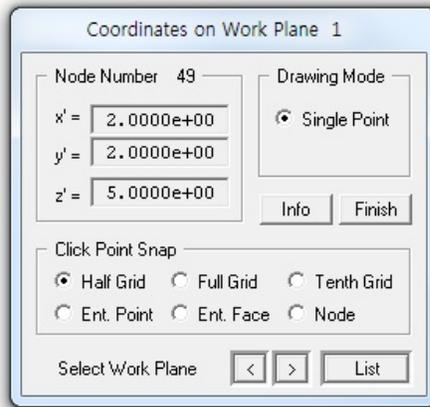


Figure 6.55 Coordinates on work plane ([Edit Node](#))

**Add**

This is used to add new node.

Before adding, work plane should be displayed on the screen.

**Build New Node** dialog similar to Figure 6.54 is displayed.

Follow the same procedure as in [Edit](#).

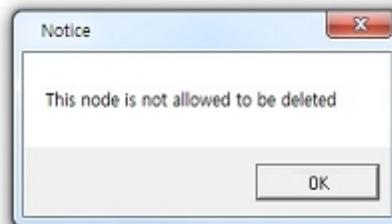
**Delete**

This is used to delete the selected node.

You can delete only standalone nodes which are not connected to elements. Refer to the notice in Figure 6.56.

Figure 6.56

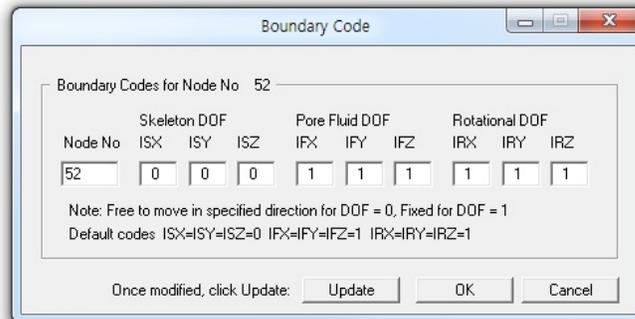
Notice on deleting connected nodes

**Boundary**

This is used to edit boundary codes associated with the current selected node as shown in Figure 6.57.

Figure 6.57

Boundary editor dialog

**Exit**

This is used to exit from the node editing mode.

### 6.6.3 Edit Title

This is used to edit the title of the finite element mesh file as shown in Figure 6.58.

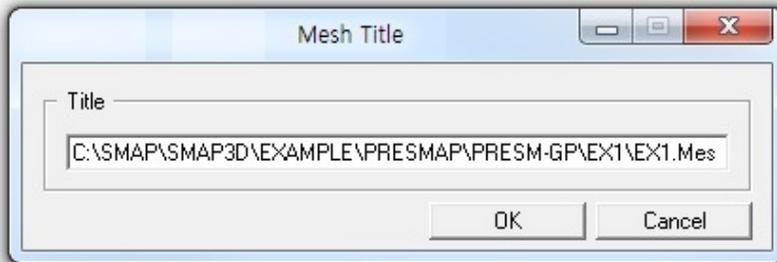


Figure 6.58 Mesh title editor dialog

# **PRESMAP**

## **User's Manual**

### **7.1 Introduction**

PRESMAP programs are mainly used to model the geometry of the structures to be analyzed. Mesh File described in Section 4.3 can be created using PRESMAP programs.

Seven PRESMAP programs are provided in this manual; PRESMAP-2D, NATM-2D, CIRCLE-2D, PRESMAP-3D, CROSS-3D, GEN-3D, PILE-3D, PRESMAP-GP, JOINT-3D. and INTERSECTION.

**PRESMAP-2D** includes Model 1, 2, 3, and 4. Model 1 is basic pre-processor which can be applied to model various types of problem geometry. Model 2 is the special pre-processor developed to model near-fields around underground openings such as tunnels, culverts, etc. Model 3 is the special pre-processor developed to model triangular and rectangular shape geometry. Model 4 is the useful pre-processor to generate layered embankments having slope.

**NATM-2D** is the special pre-processing program developed to generate automatically two-dimensional finite element meshes and boundary conditions for NATM (New Austrian Tunneling Method) tunnels.

**CIRCLE-2D** is the special pre-processing program developed to generate automatically two-dimensional finite element meshes for circular cross section with joint interface.

**PRESMAP-3D** is the basic pre-processor which can be applied to model various types of three dimensional geometries.

**CROSS-3D** is the special pre-processing program developed to generate automatically three dimensional finite element meshes and boundary conditions for crossing tunnels. The intermediate output file with file extension *.TMP* from CROSS-3D contains finite element block coordinates, indexes, and boundary conditions which are essentially input data to PRESMAP-3D.

**GEN-3D** generates coordinates, element indexes, boundary codes, external loads, and transmitting boundaries in three dimensional coordinate system by extending typical two dimensional output files from PRESMAP-2D, NATM-2D or CIRCLE-2D.

**PILE-3D** is the special pre-processor which can be used to generate all input files required for pile foundation analysis. It can generate Concrete Pile with Anchor Bolts or Steel Pipe with Concrete Cap.

**PRESMAP-GP** is the general purpose pre-processing program which can be used to generate coordinates, element indexes and boundary codes for truss, beam, shell or continuum elements. Users can select rectangular, spherical or cylindrical coordinate for interpolation.

**JOINT-3D** is the special pre-processor which can be used to generate jointed continuum finite element meshes given the conventional continuum SMAP-3D Mesh File input. For the jointed continuum analysis, each continuum finite element is surrounded by joint elements which allow slippage along the joint when reaching shear strength and debonding normal to the joint face when exceeding tensile strength.

**INTERSECTION** programs are mainly used to compute the locations of the 3D surfaces crossing each other. These surfaces consist of Shell Elements with different materials. The computed coordinates of intersections can be used for the construction of complicated three-dimensional meshes. Two methods are available: Shell Element and Two Tunnels.

PRESMAP-2D  
Model 1  
User's Manual



Card Group	Input Data and Definitions (Model 1)
General Information	1.1 <b>TITLE</b> TITLE    Any title of (Max = 60 characters)
	1.2 <b>IP</b> IP = 0    Plane strain or plane stress = 1    Axisymmetry
	1.3 NBLOCK, NBNODE, NSNEL, CMFAC                    (SMAP-S2/2D) NBLOCK, NBNODE, NSNEL, CMFAC, THI            (SMAP-T2/W2)  <a href="#">See Figure 7.1</a>  NBLOCK        Number of blocks NBNODE        Number of block nodes NSNEL           Starting element number CMFAC          Coordinate magnification factor THI              Initial temperature / total head

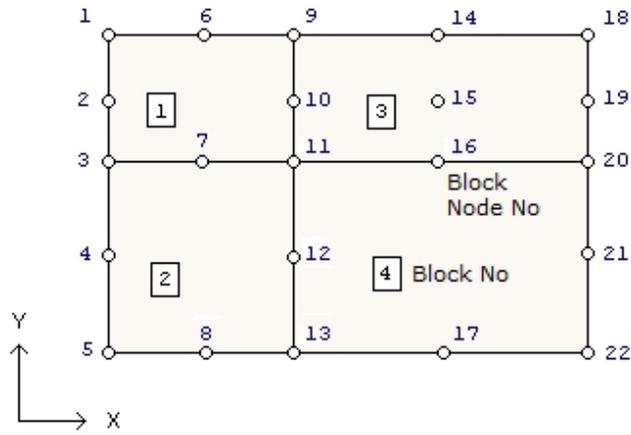




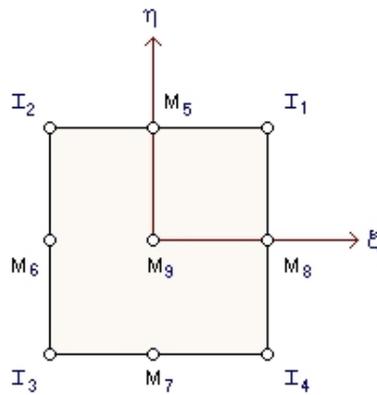


Card Group	Input Data and Definitions (Model 1)
3	<p>3.5</p> <p>MATNO, NDX, NDY, KS, KF (SMAP-2D)</p> <p>MATNO, NDX, NDY, THICK, DENSITY (SMAP-S2)</p> <p>MATNO, NDX, NDY, IDH (SMAP-T2/W2)</p> <p>           MATNO      Material property number            If <b>MATNO</b> = 0, the block is void.         </p> <p>           NDX          Number of elements in x-direction         </p> <p>           NDY          Number of elements in y-direction         </p> <p>           KS = 0      Has solid phase                     = 1      No solid phase         </p> <p>           KF = 0      Has fluid phase                     = 1      No fluid phase         </p> <p>           THICK       Thickness of element.            For plane strain, use <b>THICK</b>=1.0         </p> <p>           DENSITY     Unit weight of element         </p> <p>           IDH          Heat / water generation history ID number         </p>

Card Group	Input Data and Definitions (Model 1)	
3	<p>3.6  <b>NFSIDE</b>                      NFSIDE Number of block sides where boundary forces are specified</p>	
	Data for Each Block  Force Data for Each Specified Side (see Figure 7.4)	<p>3.7.1  <b>IEDGE, LHNO, IBF</b>                      IEDGE Edge designation number                      LHNO Load history number                      IBF = 0 No applied force                      = 1 Static fluid pressure                      = 2 Horizontal force                      = 3 Vertical force                      = 4 Horizontal and vertical force</p>
<p>3.7.2                      IBF = 1 &gt; IDIR<sub>n,r</sub> q<sub>n1,r</sub> q<sub>n2</sub>                      = 2 &gt; IDIR<sub>h,r</sub> q<sub>h1,r</sub> q<sub>h2</sub>                      = 3 &gt; IDIR<sub>v,r</sub> q<sub>v1,r</sub> q<sub>v2</sub>                      = 4 &gt; IDIR<sub>h,r</sub> q<sub>h1,r</sub> q<sub>h2</sub>                      IDIR<sub>v,r</sub> q<sub>v1,r</sub> q<sub>v2</sub>                      IDIR = 1 Pressure/force increases linearly with x                      = 2 Pressure/force increases linearly with y                      q<sub>n1,r</sub> q<sub>n2</sub> Static pressure coefficient at edge ends                      q<sub>h1,r</sub> q<sub>h2</sub> Horizontal components of load coefficients at edge ends                      q<sub>v1,r</sub> q<sub>v2</sub> Vertical components of load coefficients at edge ends</p>		



NBLOCK = 4, NBNODE = 22  
 Block number should be in order from top to bottom and left to right



For Block Number 3

$I_1 = 18$	$M_5 = 14$
$I_2 = 9$	$M_6 = 10$
$I_3 = 11$	$M_7 = 16$
$I_4 = 20$	$M_8 = 19$
$M_9 = 15$	

PRESMAP uses Serendipity interpolation if  $M_9 = 0$   
 and Lagrangion interpolation if  $M_9 \neq 0$

Figure 7.1 Block Specification and Block Index

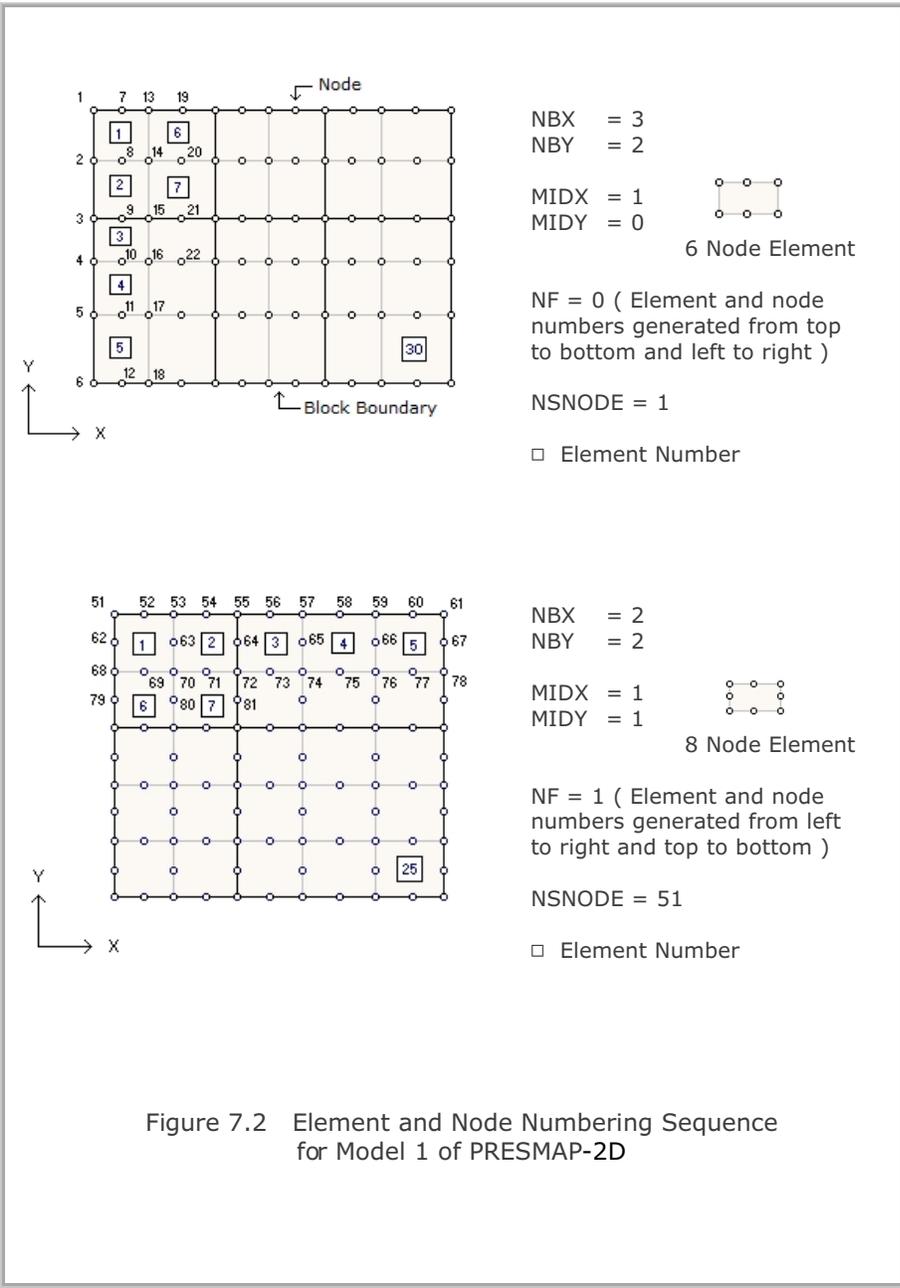


Figure 7.2 Element and Node Numbering Sequence for Model 1 of PRESMAP-2D



Boundary Type	Boundary Codes		
IB	IDX	IDY	IDT
0	0	0	1
1	1	0	1
2	0	1	1
3	1	1	1
4	0	0	0
5	1	0	0
6	0	1	0
7	1	1	0

IDX = 0 Displacement in x-direction is free  
= 1 Displacement in x-direction is fixed

IDY = 0 Displacement in y-direction is free  
= 1 Displacement in y-direction is fixed

IDT = 0 Rotational degree of freedom is free  
= 1 Rotational degree of freedom is fixed

Figure 7.3b Boundary Codes for SMAP-S2

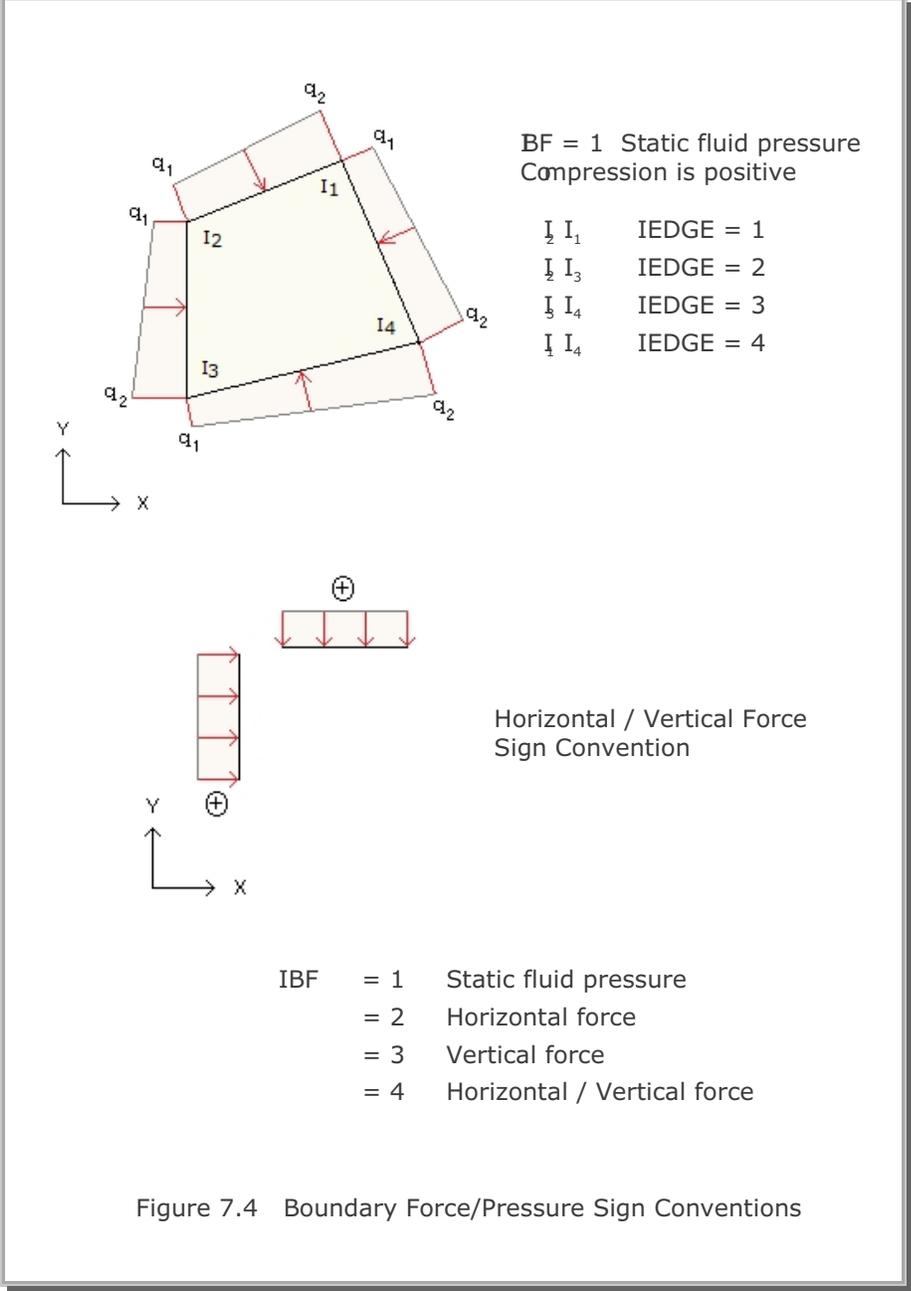


Figure 7.4 Boundary Force/Pressure Sign Conventions



PRESMAP-2D  
Model 2  
User's Manual





Card Group	Input Data and Definitions (Model 2)
2	<p>2.1</p> <p>SUBNAME</p> <p>SUBNAME Subregion name (up to 60 characters)</p>
	<p>2.2</p> <p>ISUBNO</p> <p>ISUBNO Subregion number</p>
	<p>2.3</p> <p>ISBTYPE, LSFTYPE, NSEG</p> <p><a href="#">See Figure 7.6 and 7.7</a></p> <p>ISBTYPE = 0 Column grids are normal to subregion surface            = 1 Column grids are straight line</p> <p>LSFTYPE = 0 Straight line subregion surface            = 1 Circular subregion surface</p> <p>NSEG Number of segments along subregion surface</p>

Card Group	Input Data and Definitions (Model 2)	
2	2.4	<p>2.4.1</p> <p><math>X_{A,r}</math> <math>Y_{A,r}</math> <math>X_{B,r}</math> <math>Y_B</math></p> <p><math>X_{A,r}</math> <math>Y_A</math>    X and Y coordinate of point A</p> <p><math>X_{B,r}</math> <math>Y_B</math>    X and Y coordinate of point B</p> <p>For LSFTYPE= 0</p>
	Subregion Surface (Figure 7.6 and 7.7)	<p>2.4.2</p> <p><math>R_r</math> <math>X_{O,r}</math> <math>Y_{O,r}</math> <math>\theta_{A,r}</math> <math>\theta_B</math></p> <p>R            Radius of arc AB</p> <p><math>X_{O,r}</math> <math>Y_O</math>    X and Y coordinate of circle origin</p> <p><math>\theta_{A,r}</math> <math>\theta_B</math>    Polar angle (degree) of point A and B</p> <p>For LSFTYPE1=1</p>

Card Group	Input Data and Definitions (Model 2)		
2	2.5	For ISBTYP=0	<p>2.5.1.1</p> <p>LCTYPE</p> <p>LCTYPE = 0 <math>X_C</math> and <math>Y_C</math> are specified</p> <p>          = 1 <math>X_C</math> is specified</p> <p>          = 2 <math>Y_C</math> is specified</p> <p>          = 3 <math>DRT_C</math> is specified</p>
			<p>2.5.1.2</p> <p>If LCTYPE = 0 --&gt; <math>X_C, Y_C</math></p> <p>          = 1 --&gt; <math>X_C</math></p> <p>          = 2 --&gt; <math>Y_C</math></p> <p>          = 3 --&gt; <math>DRT_C</math></p> <p><math>X_C, Y_C</math>    X and Y coordinate of point C</p> <p><math>DRT_C</math>       Length of third row block along the edge AC</p>
			<p>2.5.2.1</p> <p>LDTYPE</p> <p>LDTYPE = 0 <math>X_D</math> and <math>Y_D</math> are specified</p> <p>          = 1 <math>X_D</math> is specified</p> <p>          = 2 <math>Y_D</math> is specified</p> <p>          = 3 <math>DRT_D</math> is specified</p>
			<p>2.5.2.2</p> <p>If LDTYPE = 0 --&gt; <math>X_D, Y_D</math></p> <p>          = 1 --&gt; <math>X_D</math></p> <p>          = 2 --&gt; <math>Y_D</math></p> <p>          = 3 --&gt; <math>DRT_D</math></p> <p><math>X_D, Y_D</math>    X and Y coordinate of point D</p> <p><math>DRT_D</math>       Length of third row block along the edge BD.</p>

Card Group	Input Data and Definitions (Model 2)		
2	2.5	2.5.3	$X_{Cf} \ Y_{Cf} \ X_{Df} \ Y_{Df}$  $X_{Cf} \ Y_{Cf}$ X and Y coordinate of point C $X_{Df} \ Y_{Df}$ X and Y coordinate of point D
Data for Each Subregion	Subregion Outer Edge	For ISBTYP = 1	

Card Group	Input Data and Definitions (Model 2)
Data for Each Subregion	<p>2.6</p> <p>IBASE<sub>1</sub>, IBASE<sub>2</sub>, IBASE<sub>3</sub> (SMAP-2D)            IB<sub>B</sub>, IB<sub>A</sub>, IB<sub>C</sub>, IB<sub>D</sub>, IB<sub>AB</sub>, IB<sub>AC</sub>, IB<sub>CD</sub>, IB<sub>BD</sub> (SMAP-2D/S2)</p> <p>See Figure 7.3 in Model 1</p> <p>IBASE<sub>1</sub>, IBASE<sub>2</sub>, IBASE<sub>3</sub> First, second, and third block base boundary code            IB<sub>B</sub>, IB<sub>A</sub>, IB<sub>C</sub>, IB<sub>D</sub> Corner boundary code            IB<sub>AB</sub>, IB<sub>AC</sub>, IB<sub>CD</sub>, IB<sub>BD</sub> Edge boundary code</p>
	<p>2.7</p> <p>1<sup>st</sup> Block: MATNO<sub>1</sub>, KS<sub>1</sub>, KF<sub>1</sub> (SMAP-2D)                              MATNO<sub>1</sub>, DENSITY<sub>1</sub> (SMAP-S2)                              MATNO<sub>1</sub>, IDH<sub>1</sub> (SMAP-T2/W2)</p> <p>2<sup>nd</sup> Block: - -            3<sup>rd</sup> Block: - -</p> <p>MATNO<sub>1</sub> Material property number of first block            KS<sub>1</sub>, KF<sub>1</sub> Solid and fluid phase flag of first block            DENSITY<sub>1</sub> Unit weight of first block            IDH<sub>1</sub> Heat / water generation history ID of first block</p> <p><b>Note:</b> For KS and KF, refer to Card Group 3.5 in PRESMAP-2D Model 1 User's Manual</p>



Block numbers are in order from surface to outer edge and counterclockwise

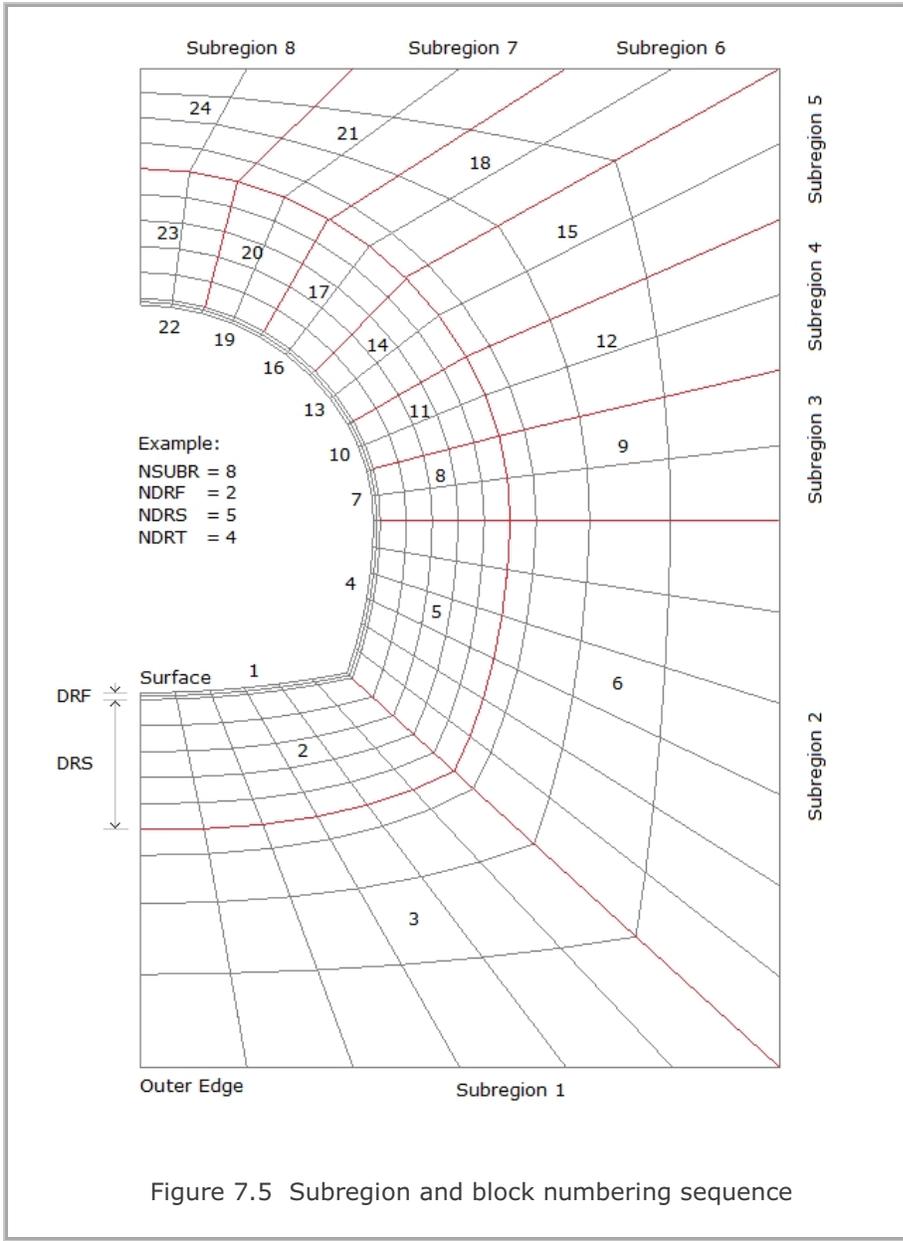


Table 7.1 Subregion parameters in Example Figure 7.5

Subregion	ISBTYP	LSFTYP	NSEG
1	1	1	6
2	1	1	6
3	0	1	2
4	0	1	2
5	0	1	2
6	0	1	2
7	0	1	2
8	0	1	2



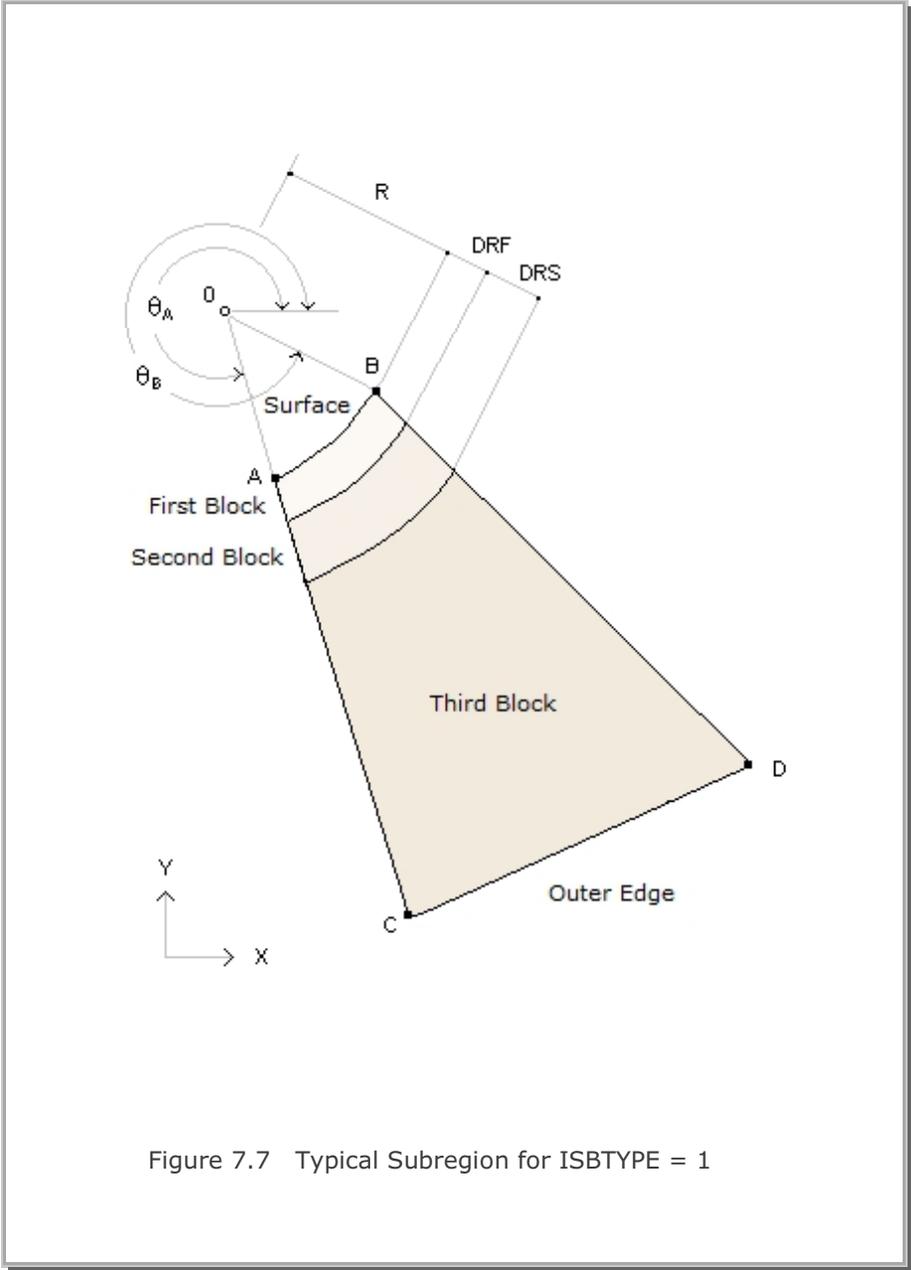
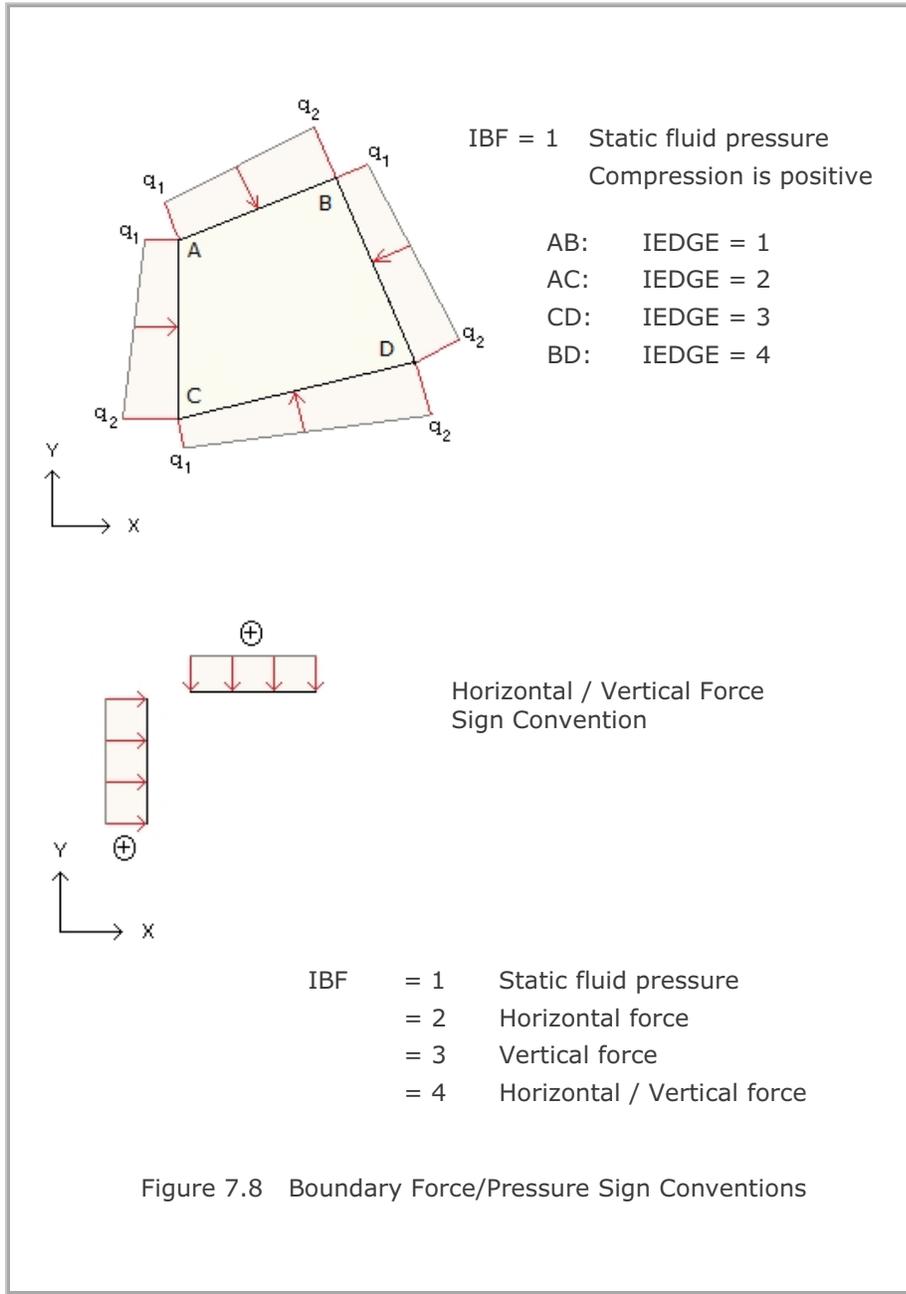


Figure 7.7 Typical Subregion for ISBTYP = 1



PRESMAP-2D  
Model 3  
User's Manual



Card Group	Input Data and Definitions (Model 3)																
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">General Information</p>	<p>1.1  <b>TITLE</b>            TITLE            Any title (Max = 60 characters)</p>																
	<p>1.2  <b>IP</b>            IP = 0            Plane geometry                 = 1            Axisymmetry geometry</p>																
	<p>1.3  <b>NBLOCK, NBNODE, NSNEL, NSNODE, CMFAC</b>   <a href="#">See Figure 7.9</a>             NBLOCK        Number of blocks            NBNODE        Number of block nodes            NSNEL           Starting element number            NSNODE        Starting node number            CMFAC         Coordinate magnification factor</p>																
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Block Coordinates</p>	<p>2.1</p> <table style="border-collapse: collapse;"> <tr> <td style="padding-right: 10px;">NBNODE</td> <td style="border-left: 1px solid black; padding-left: 5px;"> <table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>1r</sub></td> <td style="padding-right: 5px;">X<sub>1r</sub></td> <td style="padding-right: 5px;">Y<sub>1</sub></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>2r</sub></td> <td style="padding-right: 5px;">X<sub>2r</sub></td> <td style="padding-right: 5px;">Y<sub>2</sub></td> </tr> </table> </td> </tr> <tr> <td style="padding-right: 10px;">Cards</td> <td style="border-left: 1px solid black; padding-left: 5px;"> <table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> </tr> </table> </td> </tr> </table> <p style="margin-top: 20px;">           NODE        Node number            X            X-coordinate            Y            Y-coordinate</p>	NBNODE	<table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>1r</sub></td> <td style="padding-right: 5px;">X<sub>1r</sub></td> <td style="padding-right: 5px;">Y<sub>1</sub></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>2r</sub></td> <td style="padding-right: 5px;">X<sub>2r</sub></td> <td style="padding-right: 5px;">Y<sub>2</sub></td> </tr> </table>	NODE <sub>1r</sub>	X <sub>1r</sub>	Y <sub>1</sub>	NODE <sub>2r</sub>	X <sub>2r</sub>	Y <sub>2</sub>	Cards	<table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> </tr> </table>	-	-	-	-	-	-
NBNODE	<table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>1r</sub></td> <td style="padding-right: 5px;">X<sub>1r</sub></td> <td style="padding-right: 5px;">Y<sub>1</sub></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>2r</sub></td> <td style="padding-right: 5px;">X<sub>2r</sub></td> <td style="padding-right: 5px;">Y<sub>2</sub></td> </tr> </table>	NODE <sub>1r</sub>	X <sub>1r</sub>	Y <sub>1</sub>	NODE <sub>2r</sub>	X <sub>2r</sub>	Y <sub>2</sub>										
NODE <sub>1r</sub>	X <sub>1r</sub>	Y <sub>1</sub>															
NODE <sub>2r</sub>	X <sub>2r</sub>	Y <sub>2</sub>															
Cards	<table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> <td style="padding-right: 5px;">-</td> </tr> </table>	-	-	-	-	-	-										
-	-	-															
-	-	-															

Card Group	Input Data and Definitions (Model 3)
3	<p>3.1</p> <p>           IBLNO, IBLTYPE, MATNO, KS, KF      <a href="#">(SMAP-2D)</a>            IBLNO, IBLTYPE, MATNO, DENSITY    <a href="#">(SMAP-S2)</a>            IBLNO, IBLTYPE, MATNO, IDH        <a href="#">(SMAP-T2/W2)</a> </p> <p>           IBLNO      Block number            IBLTYPE    Block type            MATNO      Material number         </p> <p>           KS = 0    Has solid phase                  = 1    No solid phase         </p> <p>           KF = 0    Has fluid phase                  = 1    No fluid phase         </p> <p>           DENSITY    Unit weight         </p> <p>           IDH         Heat / water generation history ID number         </p>

Data for Each Block (see Figure 7.9)

Card Group	Input Data and Definitions (Model 3)
Data for Each Block	<p>3</p> <p>3.2</p> <p>For IBLTYPE = 1</p> <p><math>I_1, I_2, I_3, I_4,</math></p> <p><math>M_5, M_6, M_7, M_8</math></p> <p><math>I_1, I_2, I_3, I_4</math> Corner node number</p> <p><math>M_5, M_6, M_7, M_8</math> Side node number</p> <div style="text-align: center;"> <p>The diagram shows a square element divided into four quadrants by a horizontal and a vertical line. The corner nodes are labeled I1 (top-right), I2 (top-left), I3 (bottom-left), and I4 (bottom-right). The side nodes are labeled M5 (top), M6 (left), M7 (bottom), and M8 (right).</p> </div> <p><b>Note:</b> IBLTYPE = 1 generates 4 elements</p>





Card Group	Input Data and Definitions (Model 3)
Data for Each Block	<p>For IBLTYPE = 4</p> <p><math>I_1, I_2, I_3,</math></p> <p><math>M_4, M_5, M_6,</math></p> <p><math>M_7, M_8, M_9,</math></p> <p><math>M_{10}, M_{11}, M_{12}</math></p> <p><math>I_1, I_2, I_3</math> Corner node number</p> <p><math>M_4 - M_{12}</math> Side node number</p> <div style="text-align: center;"> <p>The diagram shows a large triangle with vertices labeled I1 (top), I2 (bottom-left), and I3 (bottom-right). The sides of the triangle are divided into three segments each by nodes M4, M5, M6 on the left side; M7, M8, M9 on the bottom side; and M10, M11, M12 on the right side. Lines connect these side nodes to form a central node and a grid of 9 smaller triangles within the main triangle.</p> </div> <p><b>Note:</b> IBLTYPE = 4 generates 9 elements</p>

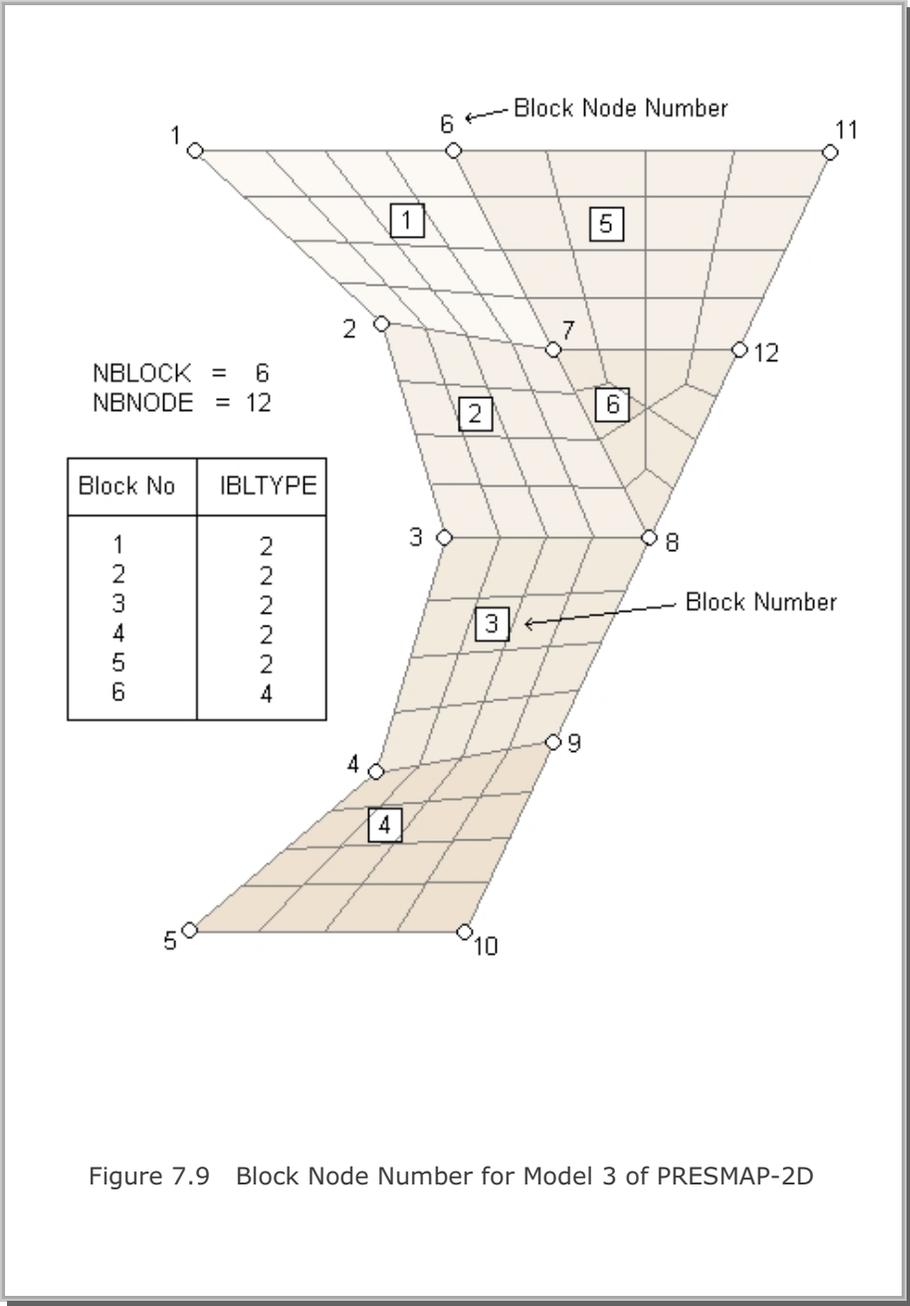


Figure 7.9 Block Node Number for Model 3 of PRESMAP-2D



PRESMAP-2D  
Model 4  
User's Manual



Card Group	Input Data and Definitions (Model 4)
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">General Information</p>	<p>1.1</p> <p><b>TITLE</b></p> <p>TITLE Any title (Max = 60 characters)</p>
	<p>1.2</p> <p>NLAYER, NDIV, ITRANGL</p> <p><a href="#">See Figure 7.10</a></p> <p>NLAYER Number of layer            NDIV Number of elements in first layer            ITRANGL = 0 Last element in each layer is rectangle                      = 1 Last element in each layer is triangle</p>
	<p>1.3</p> <p>NSNEL, NSNODE, CMFAC</p> <p>NSNEL Starting element number            NSNODE Starting node number            CMFAC Coordinate magnification factor</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Block Coordinates</p>	<p>2.1</p> <p>XB1, YB1, YB2, XB3</p> <p><a href="#">See Figure 7.10</a></p> <p>XB1, YB1 X, Y coordinate of block node 1            YB2 Y coordinate of block node 2            XB3 X coordinate of block node 3</p>



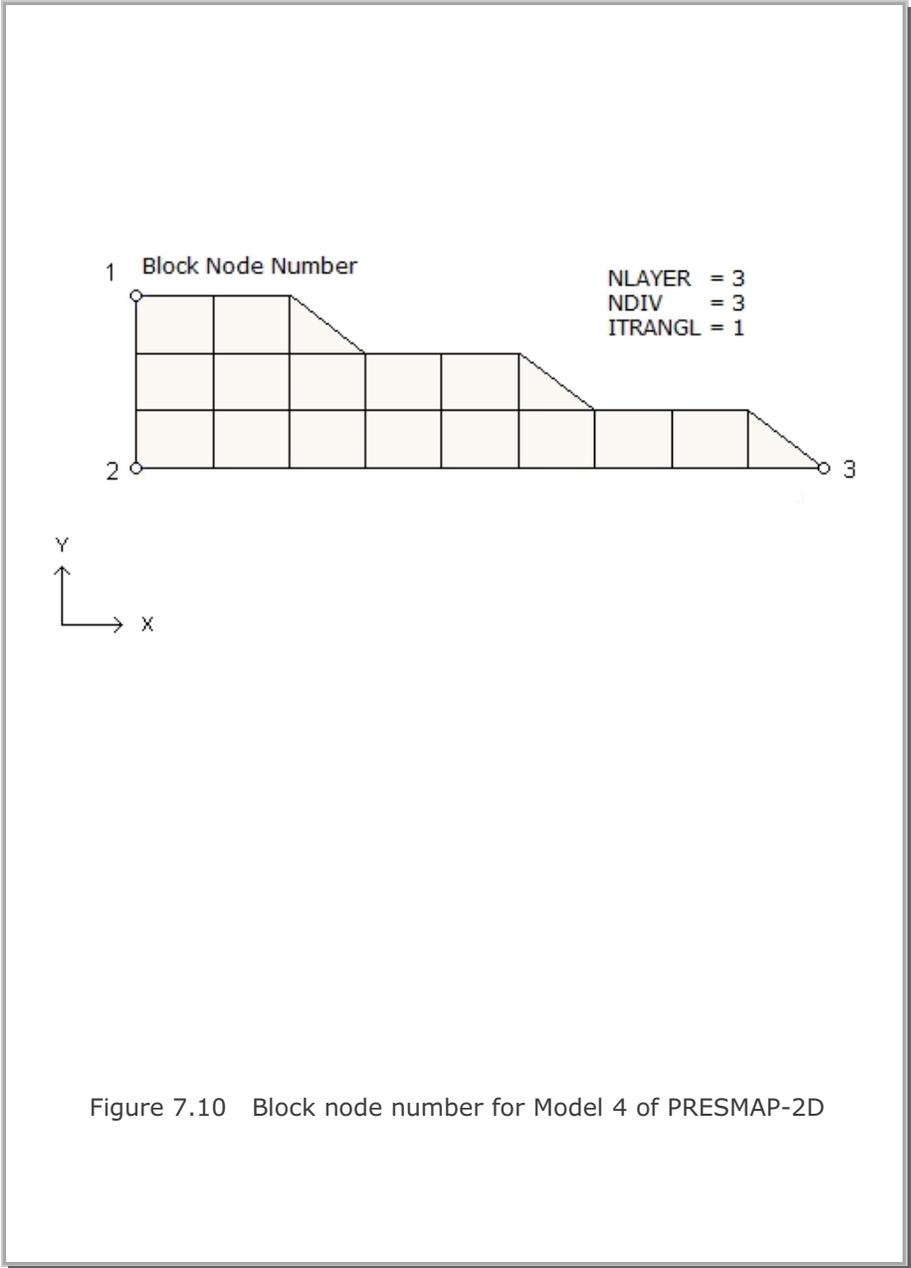


Figure 7.10 Block node number for Model 4 of PRESMAP-2D



NATM-2D  
User's Manual



Card Group	Input Data and Definitions															
General Information	<p>1.1</p> <p><b>TITLE</b></p> <p>TITLE    Any title (Max = 60 characters)</p>															
	<p>1.2</p> <p><b>IUNIT</b></p> <table border="1"> <thead> <tr> <th>IUNIT</th> <th>Length</th> <th>Force</th> <th>Pressure</th> <th>Unit Weight</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>in</td> <td>lb</td> <td>lb/in<sup>2</sup></td> <td>lb/in<sup>3</sup></td> </tr> <tr> <td>2</td> <td>m</td> <td>ton</td> <td>ton/m<sup>2</sup></td> <td>ton/m<sup>3</sup></td> </tr> </tbody> </table>	IUNIT	Length	Force	Pressure	Unit Weight	1	in	lb	lb/in <sup>2</sup>	lb/in <sup>3</sup>	2	m	ton	ton/m <sup>2</sup>	ton/m <sup>3</sup>
	IUNIT	Length	Force	Pressure	Unit Weight											
1	in	lb	lb/in <sup>2</sup>	lb/in <sup>3</sup>												
2	m	ton	ton/m <sup>2</sup>	ton/m <sup>3</sup>												
<p>1.3</p> <p>MODEL, IGEN, IEXMESH, ILNCOUPL, IAUTO</p> <p>MODEL = 1 Single tunnel (Half section )          = 2 Single tunnel (Full section )          = 3 Two tunnels (Symmetric )          = 4 Two tunnels (Unsymmetric)</p> <p>IGEN = 0 Generate whole mesh          = 1 Generate core          = 2 Generate surrounding</p> <p>IEXMESH = 0 No user supplied mesh          = 1 Add generated mesh to user supplied mesh</p> <p>For Lining analysis</p> <p>ILNCOUPL= 0 Surrounding rock by continuum element          = 1 Surrounding rock by spring element</p> <p>IAUTO = 0 Generate Mesh file          = 1 Generate Mesh, Main and Post files          Available only for SMAP-S2</p> <p><a href="#">See Figure 7.11</a></p>																

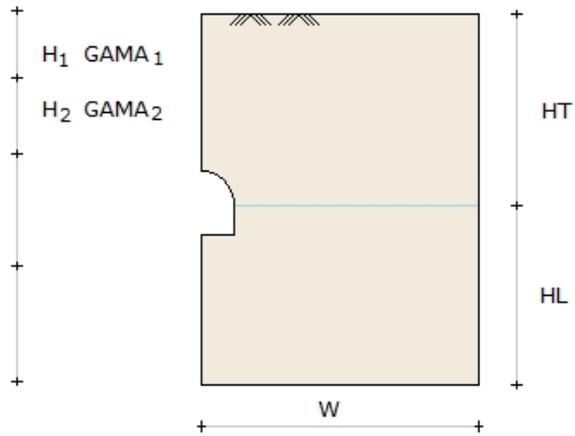








MODEL = 1 Single Tunnel (Half Section)



MODEL = 2 Single Tunnel (Full Section)

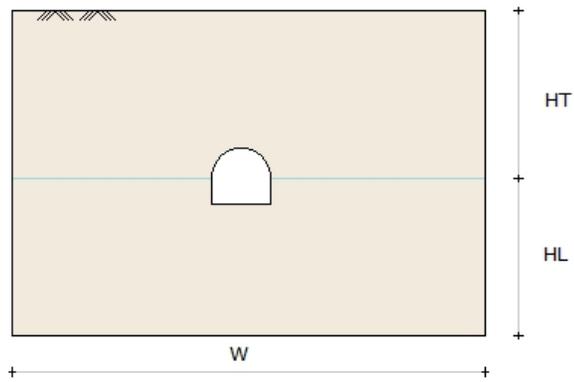
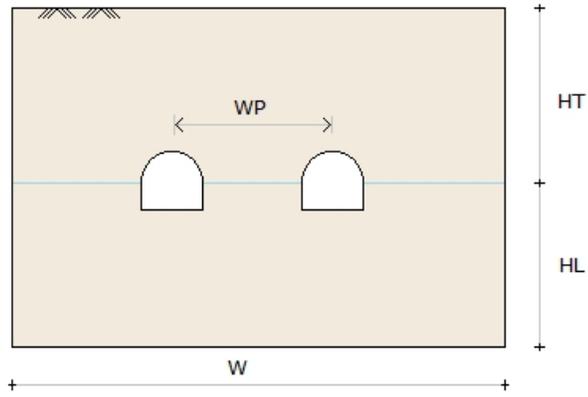


Figure 7.11 Schematic tunnel section view for MODEL = 1 and 2

MODEL = 3 Two Tunnel (Symmetric Section)



MODEL = 4 Two Tunnel (Unsymmetric Section)

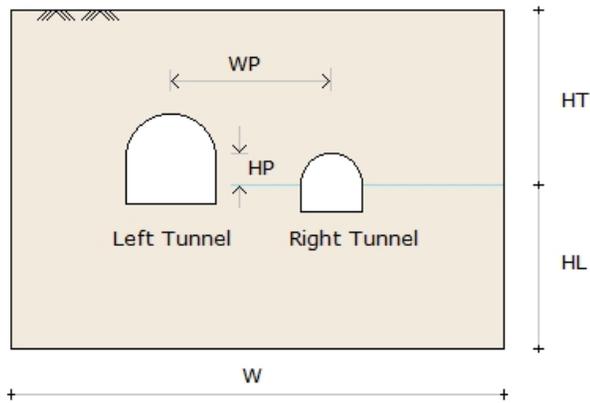


Figure 7.11 Schematic tunnel section view for MODEL = 3 and 4



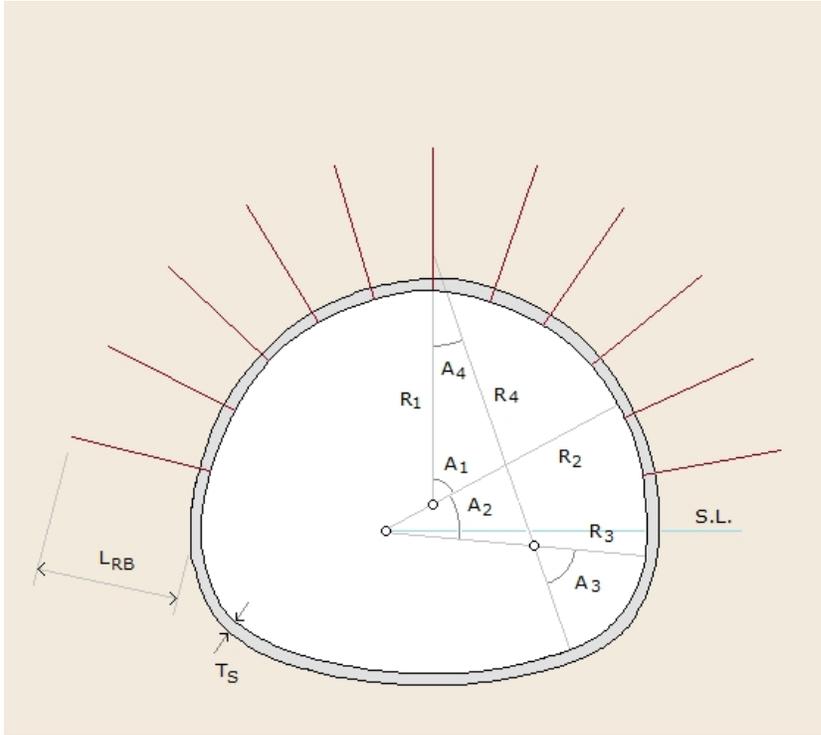


Figure 7.12 Tunnel dimension ( $A_1 + A_2 > 90$ )



CIRCLE-2D  
User's Manual



Card Group	Input Data and Definitions
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">General Information</p>	<p>1.1</p> <p><b>TITLE</b></p> <p>TITLE            Any title (Max = 80 characters)</p>
	<p>1.3</p> <p>MODEL, NSNEL, NSNODE</p> <p>MODEL = 1    Quarter Section</p> <p>          = 2    Half        Section</p> <p>          = 3    Full        Section</p> <p>NSNEL         Starting element number</p> <p>NSNODE        Starting node number</p> <p><a href="#">See Figure 7.13</a></p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Geometry</p>	<p>2.1</p> <p>R, FINEMESH, NEARMESH, NDIV, BH, BV</p> <p>R                Radius of Circular Core</p> <p>FINEMESH = 0    Coarse Mesh</p> <p>          = 1    Fine     Mesh</p> <p>NEARMESH = 0    All Quad Mesh</p> <p>          = 1    Quad and Triangle Mesh</p> <p>NDIV            Number of divisions for outer zone</p> <p>BH, BV         Horizontal and Vertical dimensions</p>



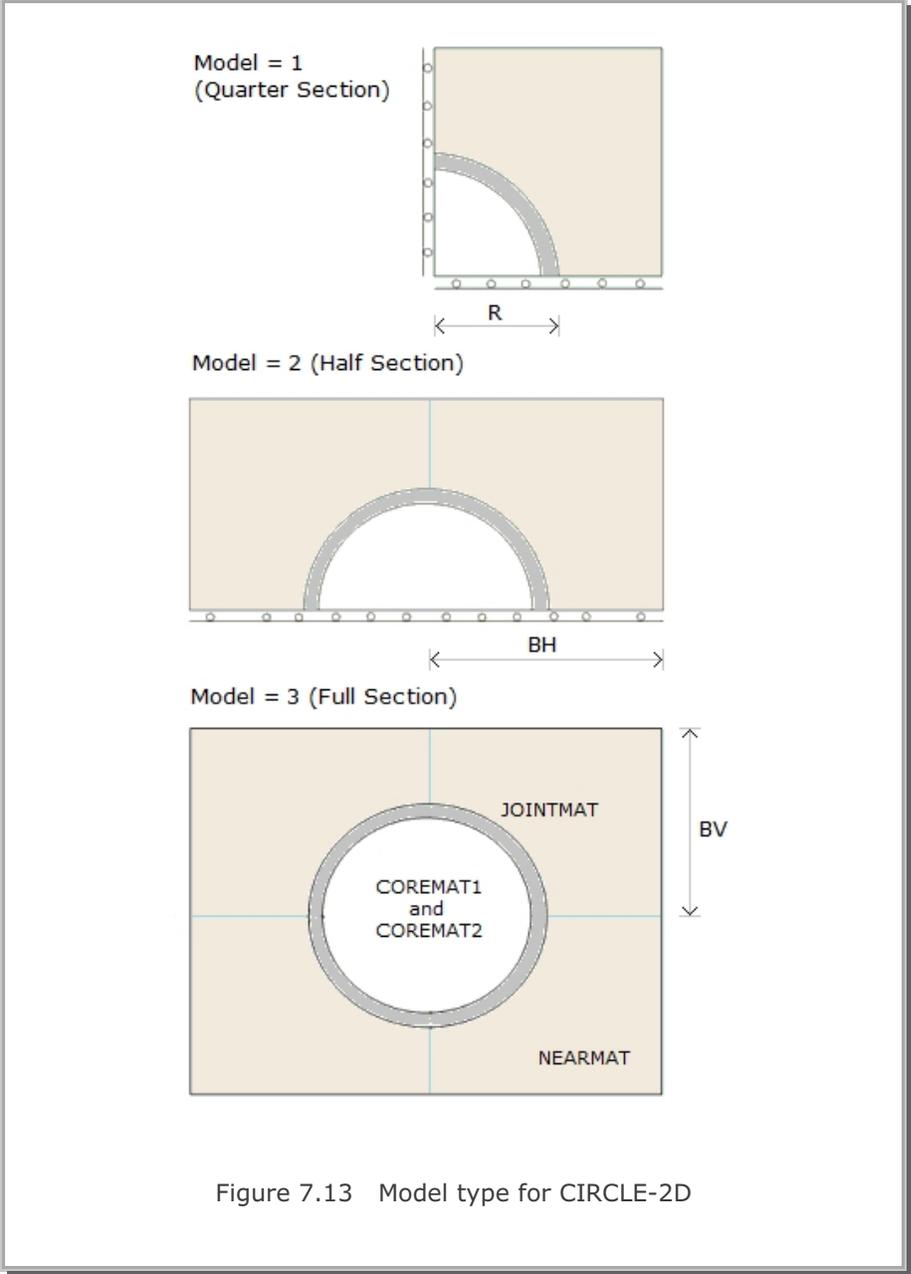


Figure 7.13 Model type for CIRCLE-2D



PRESMAP-3D  
User's Manual







Card Group	Input Data and Definitions	
3	3.4	<div style="border-bottom: 1px solid black; padding-bottom: 5px;"> <p>3.4.1</p> <p><b>NBOUND</b></p> <p> <b>NBOUND</b>    Number of boundaries to be specified.  <span style="color: blue;">If NBOUND=0, go to Card group 3.5</span> </p> </div> <div style="padding-top: 5px;"> <p>3.4.2</p> <p><b>NBOUND Cards</b></p> <p><span style="color: blue;">For SMAP-3D</span></p> <p>IBTYPE, ISX, ISY, ISZ, IFX, IFY, IFZ</p> <p><span style="color: blue;">For SMAP-T3 / W3</span></p> <p>IBTYPE, ID, IDF</p> <p> <b>IBTYPE</b> = 1    Interior volume            = 2    Front surface            = 3    Back surface            = 4    Left surface            = 5    Right surface            = 6    Top surface            = 7    Bottom surface             = 8    Line I<sub>1</sub> and I<sub>2</sub>            = 9    Line I<sub>2</sub> and I<sub>3</sub>            = 10    Line I<sub>3</sub> and I<sub>4</sub>            = 11    Line I<sub>4</sub> and I<sub>1</sub>            = 12    Line I<sub>5</sub> and I<sub>6</sub>            = 13    Line I<sub>6</sub> and I<sub>7</sub>            = 14    Line I<sub>7</sub> and I<sub>8</sub>            = 15    Line I<sub>8</sub> and I<sub>5</sub>            = 16    Line I<sub>1</sub> and I<sub>5</sub>            = 17    Line I<sub>2</sub> and I<sub>6</sub>            = 18    Line I<sub>3</sub> and I<sub>7</sub>            = 19    Line I<sub>4</sub> and I<sub>8</sub> </p> </div>

Data for Each Block

See Figure 7.14

Card Group	Input Data and Definitions	
3	Data for Each Block	<p>3.4.2</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">See Figure 7.14</p> <ul style="list-style-type: none"> <li>= 20 Node I<sub>1</sub></li> <li>= 21 Node I<sub>2</sub></li> <li>= 22 Node I<sub>3</sub></li> <li>= 23 Node I<sub>4</sub></li> <li>= 24 Node I<sub>5</sub></li> <li>= 25 Node I<sub>6</sub></li> <li>= 26 Node I<sub>7</sub></li> <li>= 27 Node I<sub>8</sub></li> </ul> <p>           ISX Skeleton X DOF            ISY Skeleton Y DOF            ISZ Skeleton Z DOF         </p> <p>           IFX Pore fluid X DOF relative to skeleton            IFY Pore fluid Y DOF relative to skeleton            IFZ Pore fluid Z DOF relative to skeleton         </p> <p>           ISX, ISY, ISZ, IFX, IFY, IFZ            = 0 Free to move in specified direction            = 1 Fixed in specified direction         </p> <p> <b>Note:</b> Default boundary conditions are            ISX=ISY=ISZ=0 and IFX=IFY=IFZ=1         </p> <p> <u>For SMAP-T3 / W3</u> </p> <ul style="list-style-type: none"> <li>ID = 0 Heat / Water flow is specified</li> <li>= 1 Temperature / Total Head is specified</li> </ul> <p>IDF = Time history identification number</p>



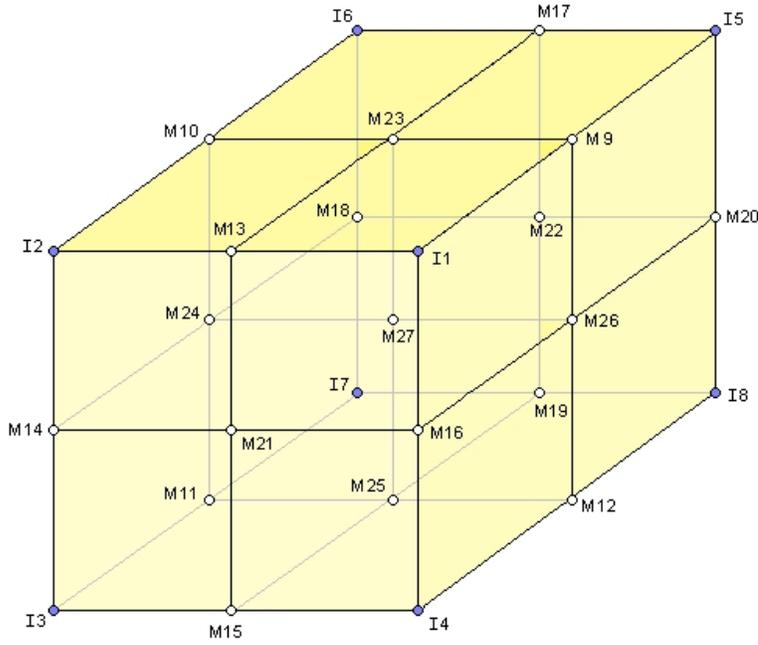


Figure 7.13 Block index for PRESMAP-3D

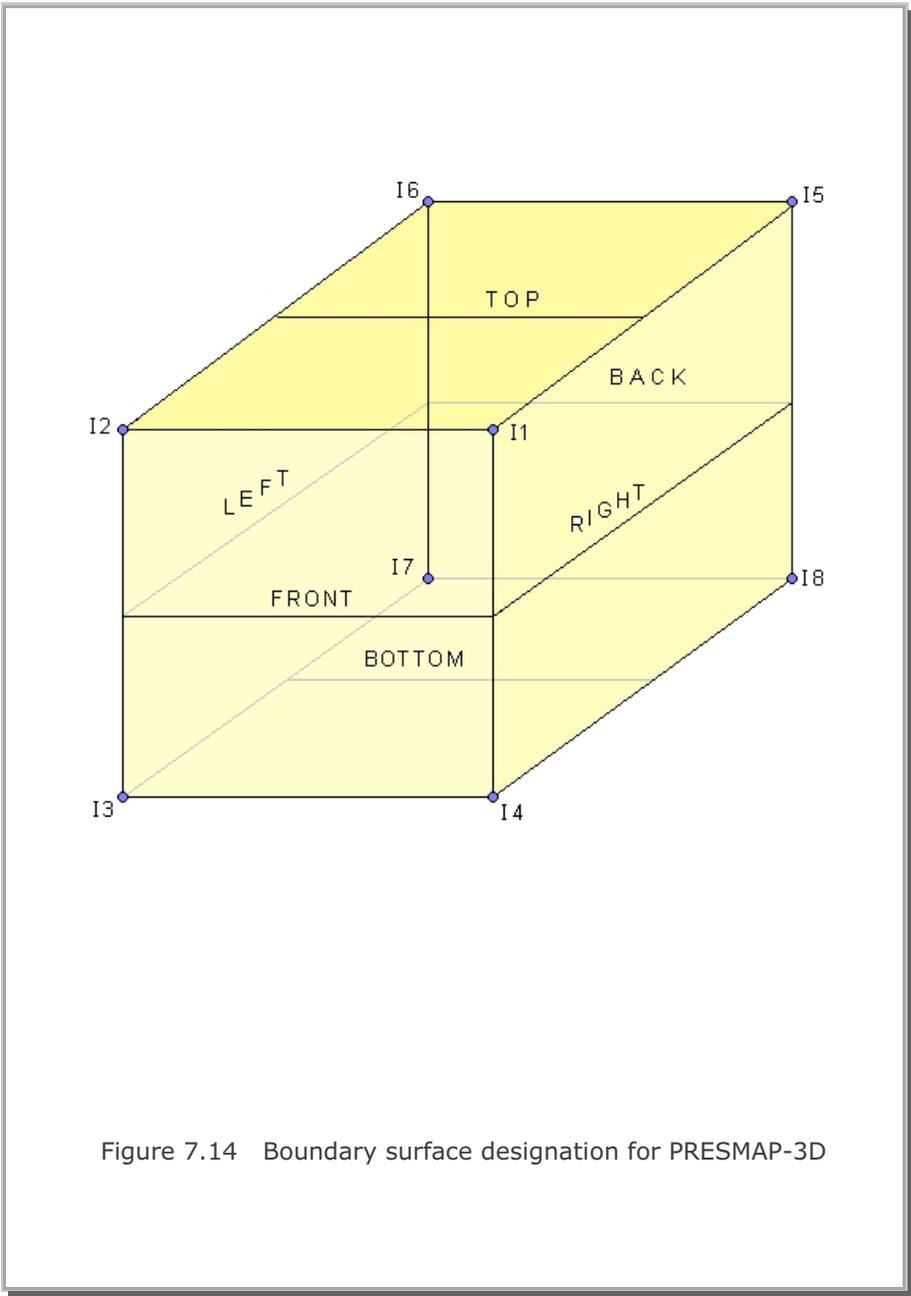


Figure 7.14 Boundary surface designation for PRESMAP-3D



CROSS-3D  
User's Manual



Card Group	Input Data and Definitions
General Information	<p>1.1  <b>TITLE</b>            TITLE Any title (Max = 80 characters)</p>
	<p>1.2</p> <p>MODELNO, KF, NSNODE, NSNEL, CMFAC (SMAP-3D)            MODELNO, IH, NSNODE, NSNEL, CMFAC (SMAP-T3/W3)</p> <p>MODELNO = 1 Identical size tunnels crossing at right angle at the same level.  <a href="#">See Figure 7.15 and 7.16</a></p> <p>= 2 Large and small tunnels crossing at right angle at the same level.  <a href="#">See Figure 7.17 and 7.18</a></p> <p>= 3 Lower and upper tunnels crossing at right angle with some clearance.  <a href="#">See Figure 7.19 and 7.20</a></p> <p>KF = 0 Element has fluid phase            = 1 Element has no fluid phase</p> <p>IH Heat/Water source ID number (SMAP-T3/W3)</p> <p>NSNODE Starting node number            NSNEL Starting element number            CMFAC Coordinate magnification factor</p>

Card Group	Input Data and Definitions
<p>2</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">For MODELNO =1 (Identical Two Crossing Tunnels, See Figures 7.15 &amp; 7.16)</p>	<p>2.1.1</p> <p>XL, YB, YT, ZL, t</p> <p>XL, YB, YT, ZL    Problem dimensions (<a href="#">See Figure 7.15</a>)</p> <p>t                      Radial distance from tunnel surface to the boundary of near region. Default value is 20% of the tunnel width. Example, t = liner thickness</p> <hr/> <p>2.1.2</p> <p>IPART, NDR, NTBND, NTOPN</p> <p>IPART = 0    Whole region (from Y =-YB to Y = YT )                    = 1    Upper region (from Y = 0.0 to Y = YT )                    = 2    Lower region (from Y =-YB to Y = 0.0)</p> <p>NDR              Number of elements along radial distance (t)</p> <p>NTBND            Number of elements along the length (XL+YB+YT+ZL)</p> <p>NTOPN            Number of elements along the perimeter of tunnel opening from node 1 to node 5. <a href="#">See Figure 7.16</a></p>

Card Group	Input Data and Definitions												
<p>2</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">For MODELNO = 1 (Identical Two Crossing Tunnels, see Figures 7.15 &amp; 7.16)</p>	<p>2.1.3</p> <p><b>NTNODE</b></p> <p>NTNODE Cards</p> <table style="border-collapse: collapse; margin-left: 40px;"> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>1,r</sub></td> <td style="padding: 0 5px;">X<sub>1,r</sub></td> <td style="padding: 0 5px;">Y<sub>1</sub></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">NODE<sub>2,r</sub></td> <td style="padding: 0 5px;">X<sub>2,r</sub></td> <td style="padding: 0 5px;">Y<sub>2</sub></td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding: 0 5px;">-</td> <td style="padding: 0 5px;">-</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 5px;">-</td> <td style="padding: 0 5px;">-</td> <td style="padding: 0 5px;">-</td> </tr> </table> <p>NTNODE      Number of nodes to specify tunnel shape</p> <p>NODE         Node number</p> <p>X              X-coordinate</p> <p>Y              Y-coordinate</p> <p><b>Note:</b> Nodes from 1 to 5 are required</p>	NODE <sub>1,r</sub>	X <sub>1,r</sub>	Y <sub>1</sub>	NODE <sub>2,r</sub>	X <sub>2,r</sub>	Y <sub>2</sub>	-	-	-	-	-	-
NODE <sub>1,r</sub>	X <sub>1,r</sub>	Y <sub>1</sub>											
NODE <sub>2,r</sub>	X <sub>2,r</sub>	Y <sub>2</sub>											
-	-	-											
-	-	-											













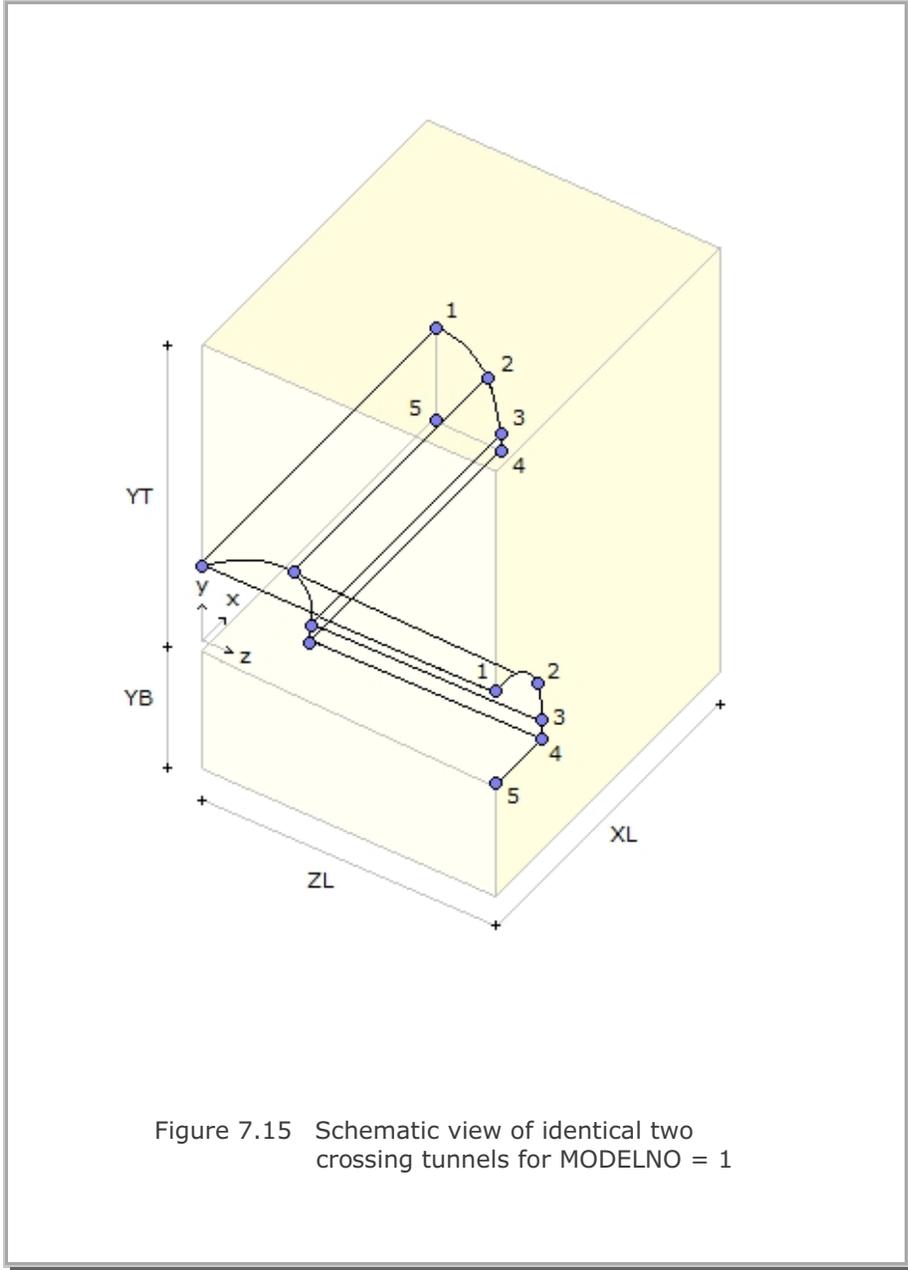


Figure 7.15 Schematic view of identical two crossing tunnels for MODELNO = 1

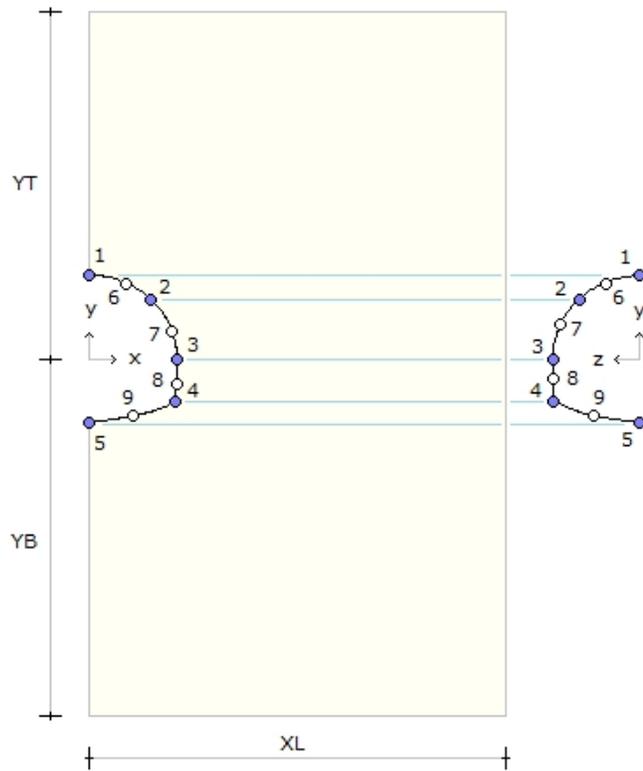


Figure 7.16 Node numbers defining tunnel shape for MODELNO = 1

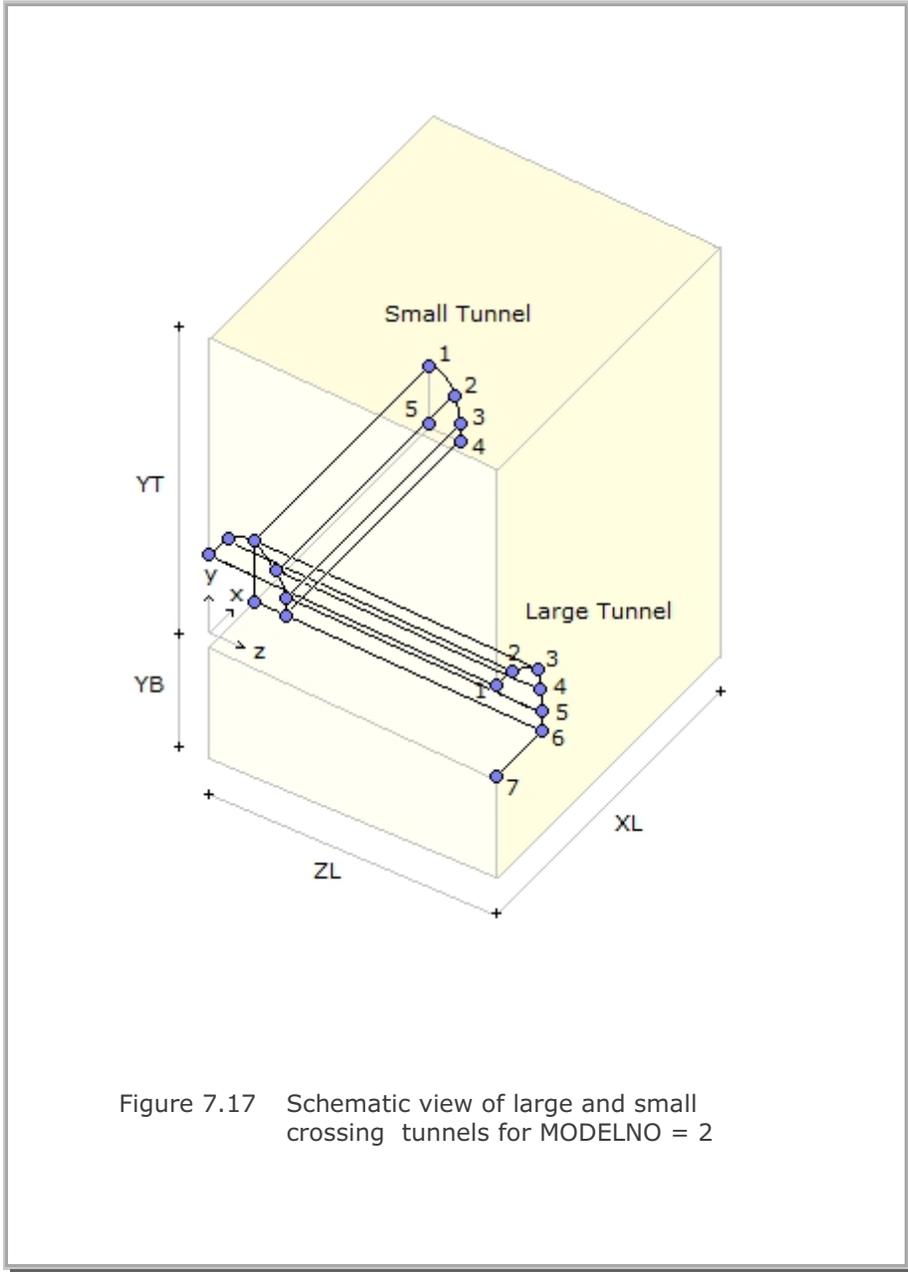


Figure 7.17 Schematic view of large and small crossing tunnels for MODELNO = 2

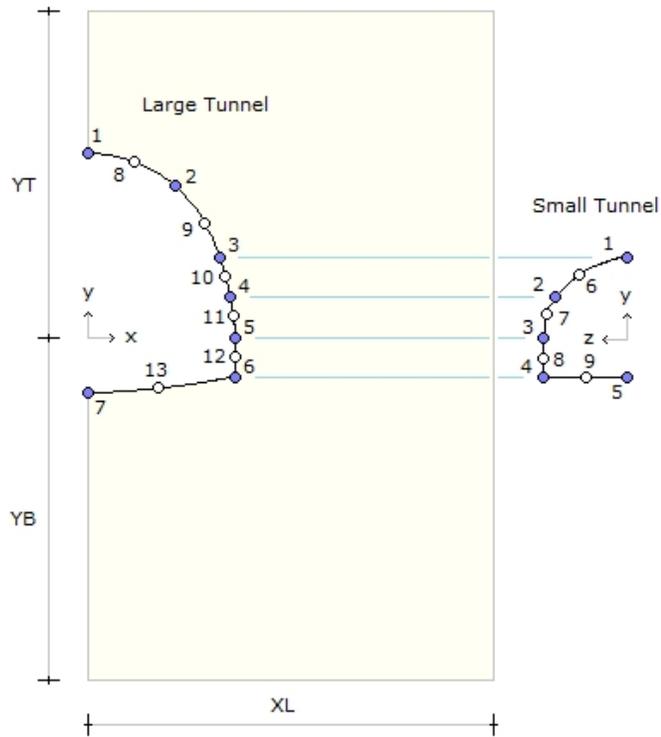


Figure 7.18 Node numbers defining tunnel shape for MODELNO = 2

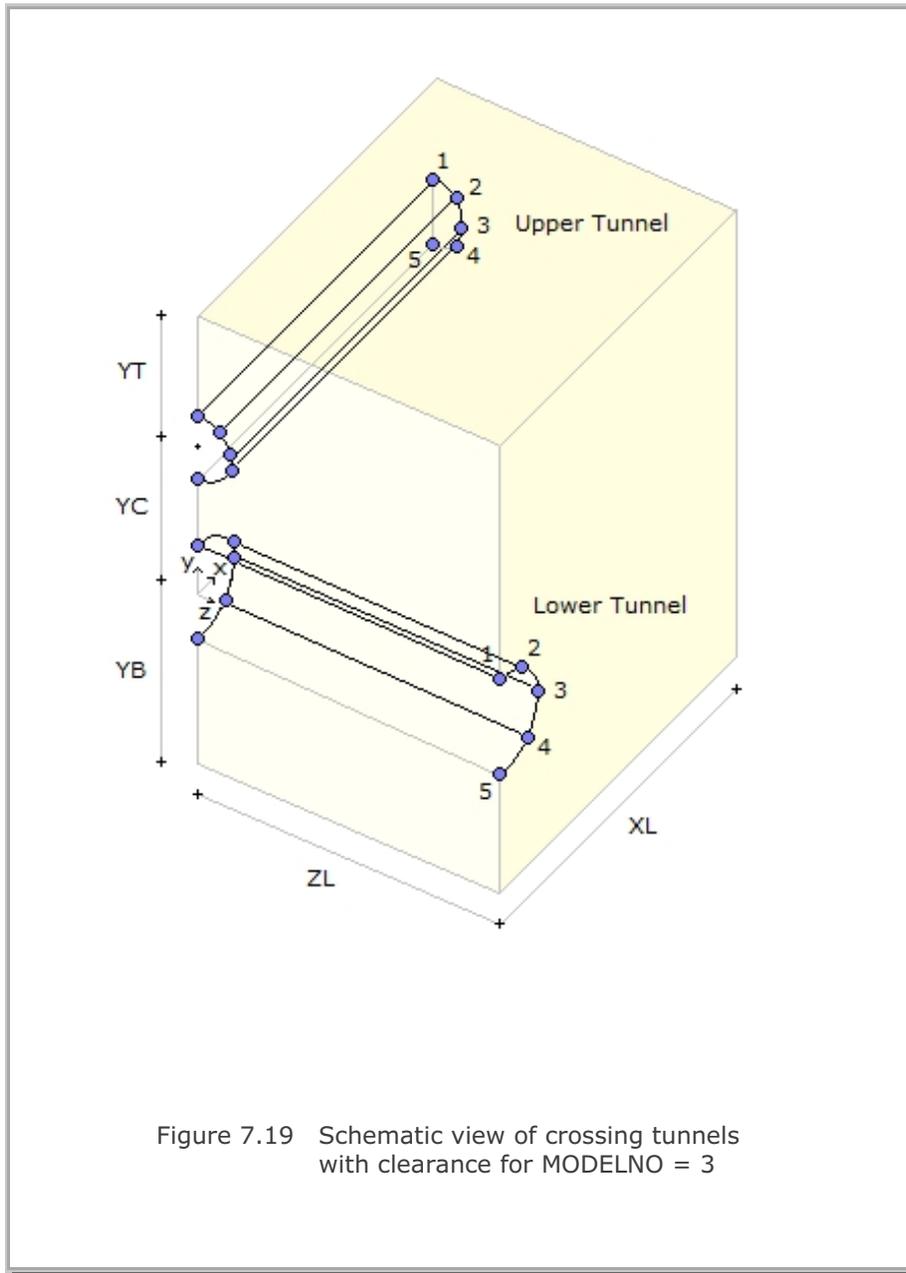


Figure 7.19 Schematic view of crossing tunnels with clearance for MODELNO = 3

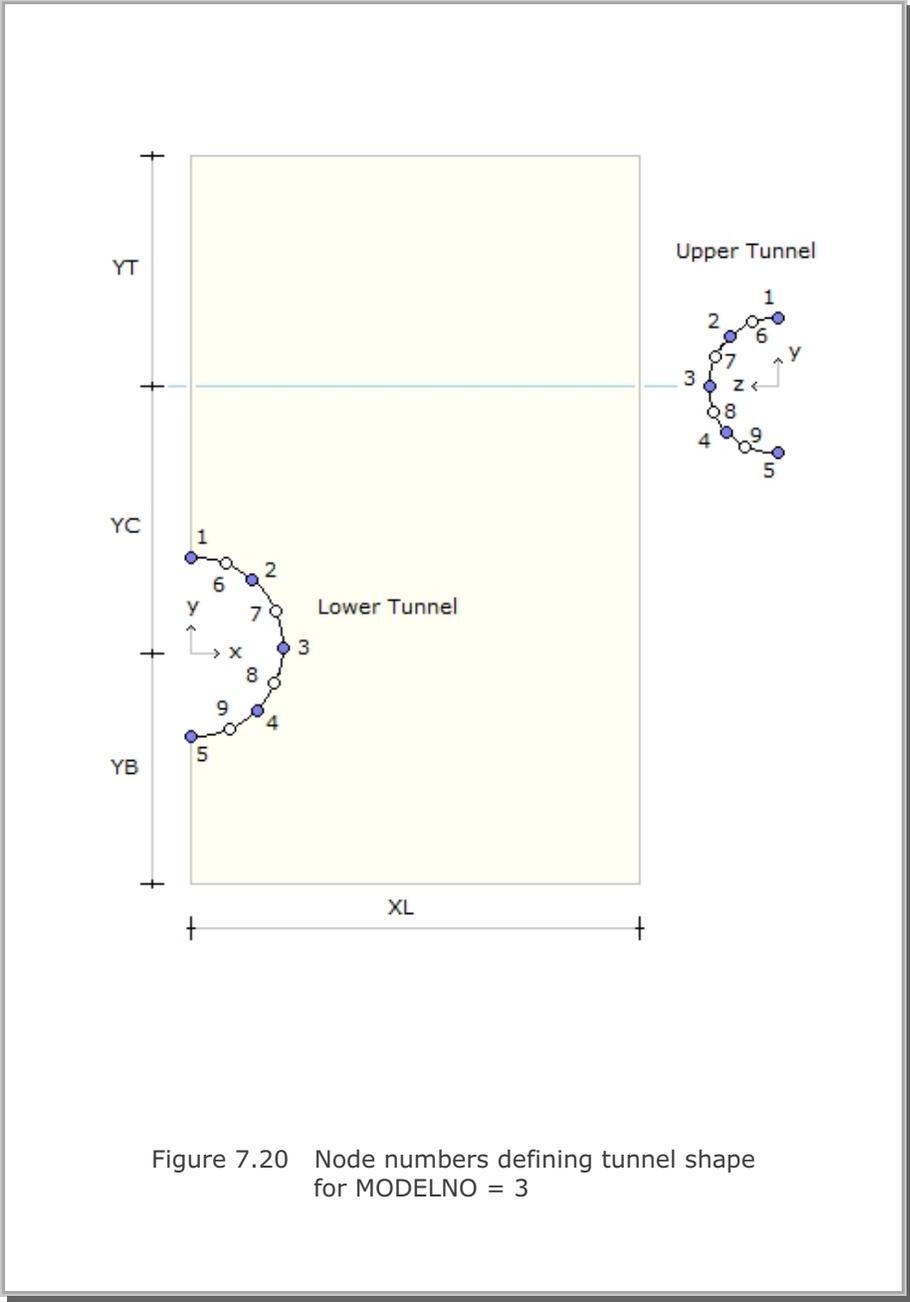


Figure 7.20 Node numbers defining tunnel shape for MODELNO = 3



GEN-3D  
User's Manual



Card Group	Input Data and Definitions
General Information	<p>1.1</p> <p><b>TITLE</b>            TITLE Any title (Max = 60 characters)</p>
	<p>1.2</p> <p><b>NBZ, NBNODE, NSNODE, NSNEL, IBOUND, IPLANE, CLOSE, CMFAC</b></p> <p>NBZ Number of blocks in z-direction            NBNODE Number of block nodes in z-direction            NSNODE Starting node number            NSNEL Starting element number</p> <p>IBOUND = 0 Do not include control boundary (Default)            = 1 Include boundary as wire frame (Truss)            = 2 Include boundary as plane surface (Shell)            = 3 Include boundary as frame and surface</p> <p>IPLANE = 0 Input 2D section in ( X, Y) plane (Default)            = 1 Input 2D section in (-Z, Y) plane            = 2 Input 2D section in ( X,-Z) plane            = 3 Input 2D section in specified plane</p> <p>ICLOSE = 0 Open loop            = 1 Closed loop            First section represents last section</p> <p>CMFAC Coordinate magnification factor for 2D sec.</p>
	<p>1.2.1</p> <p><b>If IBOUND = 0, skip this card</b></p> <p><math>X_{LEFT}, X_{RIGHT}, Y_{BOTTOM}, Y_{TOP}, Z_{BACK}, Z_{FRONT}</math></p> <p><math>X_{LEFT}, X_{RIGHT}</math> X coordinates for left &amp; right boundary  <math>Y_{BOTTOM}, Y_{TOP}</math> Y coordinates for bottom &amp; top boundary  <math>Z_{BACK}, Z_{FRONT}</math> Z coordinates for back &amp; front boundary</p>

Card Group	Input Data and Definitions														
General Information	<p>1</p> <p>1.2.2</p> <p><b>Required only if IPLANE = 3</b></p> <p><math>X_{O,r}</math> <math>Y_{O,r}</math> <math>Z_O</math>  <math>X_{a,r}</math> <math>Y_{a,r}</math> <math>Z_a</math>  <math>X_{b,r}</math> <math>Y_{b,r}</math> <math>Z_b</math></p> <p><math>X_{O,r}</math> <math>Y_{O,r}</math> <math>Z_O</math>    Coordinates defining local origin  <math>X_{a,r}</math> <math>Y_{a,r}</math> <math>Z_a</math>    Coordinates defining local x axis  <math>X_{b,r}</math> <math>Y_{b,r}</math> <math>Z_b</math>    Coordinates defining local y axis</p>														
	<p>1.3</p> <p><math>IBZ_{BASE}</math> , <math>IBZ_{FRONT}</math> , <math>IBZ_{BACK}</math>  <b>See Figure 7.21</b></p> <p><math>IBZ_{BASE}</math>        Base boundary code  <math>IBZ_{FRONT}</math>       Front surface boundary code  <math>IBZ_{BACK}</math>        Back surface boundary code</p> <table border="0" style="margin-left: 40px;"> <thead> <tr> <th><b>IBZ</b></th> <th><b>ISZ</b></th> <th><b>IFZ</b></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>2</td> <td>1</td> <td>0</td> </tr> <tr> <td>3</td> <td>1</td> <td>1</td> </tr> </tbody> </table> <p><math>ISZ</math>                Z DOF for skeleton motion  <math>IFZ</math>                Z DOF for relative pore fluid motion</p> <p><math>ISZ,IFZ = 0</math>    Free to move in specified direction.  <math>= 1</math>                Fixed in specified direction.</p> <p><b>SMAP-T3/W3</b>    <math>ID = ISZ</math> and <math>IDF = IFZ</math></p> <p><math>ID = 0</math>            Heat/Water flow is specified  <math>= 1</math>                Temperature/Total Head is specified</p> <p><math>IDF</math>                Time history identification number</p>	<b>IBZ</b>	<b>ISZ</b>	<b>IFZ</b>	0	0	0	1	0	1	2	1	0	3	1
<b>IBZ</b>	<b>ISZ</b>	<b>IFZ</b>													
0	0	0													
1	0	1													
2	1	0													
3	1	1													

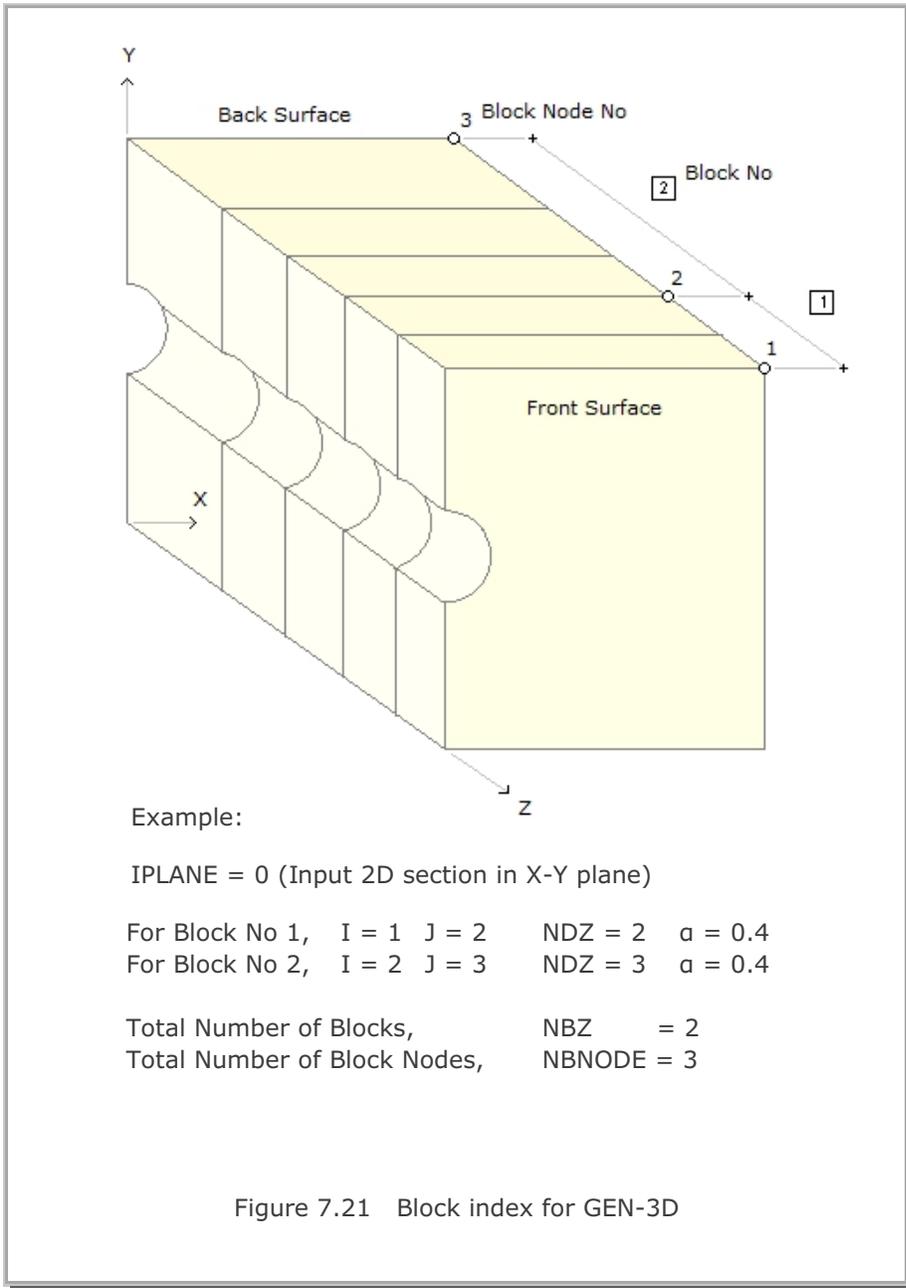
Card Group	Input Data and Definitions																															
2	<p>2.1</p> <table> <tr> <td></td> <td>┌</td> <td>NODE<sub>1</sub>,</td> <td>Z<sub>1</sub>,</td> <td>X<sub>1</sub></td> </tr> <tr> <td></td> <td> </td> <td>NODE<sub>2</sub>,</td> <td>Z<sub>2</sub>,</td> <td>X<sub>2</sub></td> </tr> <tr> <td>NBNODE</td> <td> </td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td>Cards</td> <td> </td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td></td> <td>└</td> <td>-</td> <td>-</td> <td>-</td> </tr> </table> <table> <tr> <td>NODE</td> <td>Node number</td> </tr> <tr> <td>Z</td> <td>Z coordinate</td> </tr> <tr> <td>X</td> <td>X coordinate</td> </tr> </table> <p><b>Note:</b> Z and X define the coordinates of center line</p>		┌	NODE <sub>1</sub> ,	Z <sub>1</sub> ,	X <sub>1</sub>			NODE <sub>2</sub> ,	Z <sub>2</sub> ,	X <sub>2</sub>	NBNODE		-	-	-	Cards		-	-	-		└	-	-	-	NODE	Node number	Z	Z coordinate	X	X coordinate
	┌	NODE <sub>1</sub> ,	Z <sub>1</sub> ,	X <sub>1</sub>																												
		NODE <sub>2</sub> ,	Z <sub>2</sub> ,	X <sub>2</sub>																												
NBNODE		-	-	-																												
Cards		-	-	-																												
	└	-	-	-																												
NODE	Node number																															
Z	Z coordinate																															
X	X coordinate																															

Block Coordinate



Card Group	Input Data and Definitions	
3	<p>3.6</p> <p>Required only for NIXCH &gt; 0</p> <p>NIXCH [ MAT, NMAT, NI<sub>1</sub>, NI<sub>2</sub>, NI<sub>3</sub>, NI<sub>4</sub>, NI<sub>5</sub>, NI<sub>6</sub>, NI<sub>7</sub>, NI<sub>8</sub> Cards [ - - - - - - - - - -</p> <p>MAT      Material number NMAT     New material number NI<sub>i</sub>      Index number increment at NI<sub>i</sub></p> <p>Note:      Index change applied only for block first layer. If NMAT = -1, it assumes that new material property number 1 consists of joint elements whose joint face designates number KS = 6</p>	
Transmitting Boundary Generation	<p>4.1</p> <p>ITRANB</p> <p>ITRANB = 0    Do not generate transmitting boundary           = 1    Generate transmitting boundary           = 2    Generate element transmitting boundary</p> <p>If ITRANB = 0, rest of Cards are not used If ITRANB = 2, go to Card Group 4.4</p>	
	4.2.	<p>4.2.1</p> <p>NTNC</p> <p>NTNC      Number of material property set</p>
	Material Property	<p>4.2.21</p> <p>NTNC [ MAT, RHO, CP, CS Cards [ - - - -</p> <p>MAT      Material number RHO      Mass density CP        Compression wave speed CS        Shear wave speed</p>

Card Group	Input Data and Definitions
4	<div style="display: flex; justify-content: space-between;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); font-weight: bold; padding-right: 10px;">Transmitting Boundary Generation</div> <div> <p>4.3</p> <p><u>Nodal Transmitting Boundary Generation</u></p> <p>(Can be repeated in any order)</p> <p>For surface whose normal is x-direction,      1 NPT N<sub>1</sub>, N<sub>2</sub>, ..., N<sub>NPT</sub></p> <p>For surface whose normal is y-direction,      2 NPT N<sub>1</sub>, N<sub>2</sub>, ..., N<sub>NPT</sub></p> <p>For surface whose normal is z-direction (Front Surface)      3</p> <p>For surface whose normal is z-direction (Back Surface)      4</p> <p>For end of transmitting boundary generation,      0</p> <p>NPT                      Number of nodes N<sub>1</sub>, N<sub>2</sub>, ..., N<sub>NPT</sub>      Node numbers</p> <hr/> <p>4.4</p> <p><u>Element Transmitting Boundary Generation</u></p> <p>(Can be repeated in any order)</p> <p>For surface whose normal is X-Y plane      1 NPT N<sub>1</sub>, N<sub>2</sub>, ..., N<sub>NPT</sub></p> <p>For front surface,      3</p> <p>For back surface,      4</p> <p>For end of transmitting boundary generation,      0</p> <p>NPT                      Number of nodes N<sub>1</sub>, N<sub>2</sub>, ..., N<sub>NPT</sub>      Node numbers</p> </div> </div>





PRESMAP-GP  
User's Manual



Card Group	Input Data and Definitions
General Information	<p>1.1</p> <p><b>TITLE</b></p> <p>TITLE Any title (Max = 80 characters)</p> <p><b>Note:</b> Following two cards are required at the beginning  <a href="#">StartPresmap</a>  <a href="#">VersionNo = 7.000</a></p>
	<p>1.2</p> <p>NBLOCK, NBNODE, NSNODE, NSNEL, IGBND, ISMAP, CMFAC, ICOMP</p> <p>NBLOCK            Number of blocks  NBNODE            Number of block nodes  NSNODE            Starting node number  NSNEL              Starting element number</p> <p>IGBND = 0        Do not generate            = 1        Generate global boundary conditions based on Card 1.3</p> <p>Mesh generation program (ISMAP)</p> <p>SMAP-S2 ( 1 )    SMAP-2D ( 2 )  SMAP-S3 ( 3 )    SMAP-3D ( 3 )  SMAP-T2 (-2 )    SMAP-T3 (-3 )  SMAP-W2 ( 9 )    SMAP-W3 (10 )  SMAP-C2 (11 )    SMAP-C3 (12 )</p> <p>CMFAC             Coordinate magnification factor</p> <p>ICOMP = 0        Do not impose            = 1        Impose compatibility between blocks</p> <p><b>Note:</b> If <b>NBLOCK</b> is negative value, the output file contains plotting information for block diagram</p>

Card Group	Input Data and Definitions
1	<p>1.3</p> <p>Six cards starting from right, left, top, bottom, front, back</p> <p><u>For SMAP-S2 / S3 / 2D / 3D / C2 / C3</u></p> <p>ISG, ISX, ISY, ISZ, IFG, IFX, IFY, IFZ, IRG, IRX, IRY, IRZ</p> <p><u>For SMAP-T2 / T3</u></p> <p>ITG, IDF, T, CF</p> <p><u>For SMAP-W2 / W3</u></p> <p>IHG, IDF, H, CF</p> <div style="margin-left: 40px;"> <p>ISG, IFG, IRG = 0 None</p> <p style="margin-left: 20px;">= 1 Free boundary</p> <p style="margin-left: 20px;">= 2 Fixed boundary</p> <p style="margin-left: 20px;">= 3 Roller boundary</p> <p style="margin-left: 20px;">= 4 Specified in X, Y, Z directions</p> </div> <div style="margin-left: 40px;"> <p>ITG = 0 None</p> <p style="margin-left: 20px;">= 1 Heat flow</p> <p style="margin-left: 20px;">= 2 Temperature</p> </div> <div style="margin-left: 40px;"> <p>IHG = 0 None</p> <p style="margin-left: 20px;">= 1 Water Flow</p> <p style="margin-left: 20px;">= 2 Total head</p> <p style="margin-left: 20px;">= 3 Potential seepage face</p> </div> <div style="margin-left: 40px;"> <p>IDF Time function identification number</p> <p>T Initial temperature</p> <p>H Initial total head</p> <p>CF Time function coefficient</p> </div> <hr/> <p>1.4</p> <p>ELMIN, MAXNEL</p> <div style="margin-left: 40px;"> <p>ELMIN Minimum element length</p> <p>MAXNEL Maximum number of elements</p> </div>







Card Group	Input Data and Definitions
<p>3</p> <p>Data for Each Line Block [ IBETYPE = 1 ]</p>	<p>3.3</p> <p><math>I_1, I_2</math>  <math>M_3</math>  <math>M_4</math>  <math>M_5, M_6, M_7</math></p> <p><a href="#">See Figure 7.22</a></p> <p><math>I_1 - I_2</math> Corner node number of a block  <math>M_3</math> Side node number of a block  <math>M_4</math> Reference node number</p> <p><a href="#">For ICOORD = 2</a></p> <p><math>M_5</math> Node number defining origin of spherical coordinate</p> <p><a href="#">For ICOORD = 3</a></p> <p><math>M_5</math> Node number defining reference origin of cylindrical coordinate  <math>M_6</math> Node number defining cylinder axis <math>M_5 - M_6</math>  <math>M_7</math> Node number defining other local axis <math>M_5 - M_7</math> which is normal to cylinder axis.</p>



Card Group	Input Data and Definitions
<p>3</p> <p>Data for Each Line Block [ IBETYPE = 1 ]</p>	<p>3.5</p> <p>MATNO, NDX</p> <p>MATNO      Material property number</p> <p>NDX         Number of elements in x-direction</p>



Card Group	Input Data and Definitions
<p>3</p> <p>Data for Each Quad Surface Block [ IBETYPE = 2 ]</p>	<p>3.3</p> <p><math>I_{1,}</math> <math>I_{2,}</math> <math>I_{3,}</math> <math>I_{4,}</math>  <math>M_{5,}</math> <math>M_{6,}</math> <math>M_{7,}</math> <math>M_{8,}</math>  <math>M_9</math>  <math>M_{10,}</math> <math>M_{11,}</math> <math>M_{12}</math></p> <p><a href="#">See Figure 7.22</a></p> <p><math>I_1 - I_4</math> Corner node number of a block  <math>M_5 - M_8</math> Side node number of a block  <math>M_9</math> Center node number of a block, used for <a href="#">ILAG = 1</a></p> <p><a href="#">For ICOORD = 2</a></p> <p><math>M_{10}</math> Node number defining origin of spherical coordinate</p> <p><a href="#">For ICOORD = 3</a></p> <p><math>M_{10}</math> Node number defining reference origin of cylindrical coordinate  <math>M_{11}</math> Node number defining cylinder axis <math>M_{10} - M_{11}</math>  <math>M_{12}</math> Node number defining other local axis <math>M_{10} - M_{12}</math> which is normal to cylinder axis</p>









Card Group	Input Data and Definitions
<p>3</p> <p>Data for Each Triangle Surface Block [ IBETYPE = -2 ]</p>	<p>3.3</p> <p><math>I_{1r}</math> <math>I_{2r}</math> <math>I_3</math>  <math>M_{4r}</math> <math>M_5</math> <math>M_6</math>  <math>M_7</math>  <math>M_{8r}</math> <math>M_{9r}</math> <math>M_{10}</math></p> <p><a href="#">See Figure 7.22</a></p> <p><math>I_1 - I_3</math> Corner node number of a block  <math>M_{4r} - M_6</math> Side node number of a block  <math>M_7</math> Center node number of a block for <b>ILAG = 1</b></p> <p><u>For ICOORD = 2</u></p> <p><math>M_8</math> Node number defining origin of spherical coordinate</p> <p><u>For ICOORD = 3</u></p> <p><math>M_8</math> Node number defining reference origin of cylindrical coordinate.  <math>M_9</math> Node number defining cylinder axis <math>M_8 - M_9</math>  <math>M_{10}</math> Node number defining other local axis <math>M_8 - M_{10}</math> which is normal to cylinder axis.</p>

Card Group	Input Data and Definitions	
3	3.4	<p>3.4.1</p> <p><b>NBOUND</b></p> <p>NBOUND      Number of boundaries to be specified  <span style="color: blue;">If NBOUND = 0, go to Card group 3.5</span></p> <hr/> <p>3.4.2</p> <p><span style="color: blue;">NBOUND cards</span></p> <p><span style="color: blue;">For SMAP-S2 / S3 / 2D / 3D / C2 / C3</span></p> <p>IBTYPE, ISX, ISY, ISZ, IFX, IFY, IFZ, IRX, IRY, IRZ</p> <p><span style="color: blue;">For SMAP-T2 / T3 / W2 / W3</span></p> <p>IBTYPE, ID, IDF, TH, CF</p> <p>           IBTYPE = 1 Interior surface      = 2 Line I<sub>1</sub> - I<sub>2</sub>                      = 3 Line I<sub>2</sub> - I<sub>3</sub>            = 4 Line I<sub>3</sub> - I<sub>1</sub>                      = 5 Node I<sub>1</sub>      = 6 Node I<sub>2</sub>      = 7 Node I<sub>3</sub> </p> <p>           Skeleton X, Y, Z DOF : ISX, ISY, ISZ            Pore fluid X, Y, Z DOF relative to skeleton : IFX, IFY, IFZ            Rotational DOF about X, Y, Z axis : IRX, IRY, IRZ         </p> <p>           ISX, ISY, ISZ, IFX, IFY, IFZ, IRX, IRY, IRZ                  = 0 Free to move in specified direction                  = 1 Fixed in specified direction         </p> <p>           Default boundary conditions            ISX=ISY=ISZ=0, IFX=IFY=IFZ=1, IRX=IRY=IRZ=0         </p> <p><span style="color: blue;">For SMAP-T2 / T3 / W2 / W3</span></p> <p>           ID = 0 Heat / <span style="color: blue;">Water</span> flow is specified                  = 1 Temperature / <span style="color: blue;">Head</span> is specified                  = 3 <span style="color: blue;">Potential seepage face</span> is specified         </p> <p>           IDF      Time function identification number            TH      Initial temperature / <span style="color: blue;">Initial total head</span>            CF      Time function coefficient         </p>

Card Group	Input Data and Definitions
<p>3</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Data for Each Triangle Surface Block [ IBETYPE = -2 ]</p>	<p>3.5</p> <p>MATNO, NDXY            THICK, DENSITY (For ISMAP = 1)            KS, KF (For ISMAP = 2, 11)            IDH (For ISMAP = -2, -3, 9, 10)</p> <p>MATNO Material property number            NDXY Number of elements along triangle edge            For wedge surface block, use negative NDXY            Refer to Example problem 11</p> <p>THICK Thickness of element.            For plane strain, use THICK = 1.0</p> <p>DENSITY Unit weight of element</p> <p>KS = -1 Element has high explosive solid phase            = 0 Element has solid phase            &gt; 0 Element has joint and absolute value of KS            represents face designation number.</p> <p>KF = 0 Element has fluid phase            = 1 Element has no fluid phase</p> <p>IDH Heat / Water generation history ID number</p>









Card Group	Input Data and Definitions
<p>3</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Data for Each Hexahedron Volume Block [ IBETYPE = 3 ]</p>	<p>3.4.2</p> <p>IBTYPE = 25 Node I<sub>6</sub>            = 26 Node I<sub>7</sub>            = 27 Node I<sub>8</sub></p> <p><a href="#">See Figure 7.23</a></p> <p>Skeleton X, Y, Z DOF : ISX, ISY, ISZ            Pore fluid X, Y, Z DOF relative to skeleton : IFX, IFY, IFZ            Rotational DOF about X, Y, Z axis : IRX, IRY, IRZ</p> <p>ISX, ISY, ISZ, IFX, IFY, IFZ, IRX, IRY, IRZ            = 0 Free to move in specified direction            = 1 Fixed in specified direction</p> <p>Default boundary conditions            ISX=ISY=ISZ=0, IFX=IFY=IFZ=1, IRX=IRY=IRZ=1</p> <p><a href="#">For SMAP-T3 / W3</a></p> <p>ID = 0 Heat / <b>Water</b> flow is specified            = 1 Temperature / <b>Head</b> is specified            = 3 <b>Potential seepage face</b> is specified</p> <p>IDF Time function identification number            TH Initial temperature / <b>Initial total head</b>            CF Time function coefficient</p>

Card Group	Input Data and Definitions
<p>3</p> <p>Data for Each Hexahedron Volume Block [ IBETYPE = 3 ]</p>	<p>3.5</p> <p>MATNO, NDX, NDY, NDZ, KS, KF (For ISMAP = 3, 12)  MATNO, NDX, NDY, NDZ, IDH (For ISMAP = -3, 10)  NT<sub>1</sub>, NT<sub>2</sub>, NT<sub>3</sub>, NT<sub>4</sub>  MAT<sub>1</sub>, MAT<sub>2</sub>, MAT<sub>3</sub>, MAT<sub>4</sub></p> <p>MATNO Material property number</p> <p>NDX Number of elements in I<sub>2</sub> - I<sub>1</sub> direction  NDY Number of elements in I<sub>2</sub> - I<sub>3</sub> direction  NDZ Number of elements in I<sub>2</sub> - I<sub>6</sub> direction</p> <p>KS = -1 Element has high explosive solid phase  = 0 Element has solid phase  &gt; 0 Element has joint and absolute value of <b>KS</b> represents face designation number.</p> <p>KF = 0 Element has fluid phase  = 1 Element has no fluid phase</p> <p>IDH Heat / <b>Water</b> generation history ID number</p> <p>NT &amp; MAT See descriptions on page 7-92</p>



Card Group	Input Data and Definitions
<p>3</p> <p>Data for Each Prism Volume Block [ IBETYPE = -3 ]</p>	<p>3.3</p> <p><math>I_{1,}, I_{2,}, I_{3,}, I_{4,}, I_{5,}, I_{6,}</math>  <math>M_{7,}, M_{8,}, M_{9,}, M_{10,}, M_{11,}, M_{12,}, M_{13,}, M_{14,}, M_{15,}, M_{16,}, M_{17,}</math>  <math>M_{18,}, M_{19,}, M_{20,}, M_{21,}</math>  <math>M_{22,}, M_{23,}, M_{24,}</math></p> <p><a href="#">See Figure 7.22</a></p> <p><math>I_1 - I_6</math> Corner node number of a block  <math>M_7 - M_{20}</math> Side node number of a block  <math>M_{21}</math> Center node number of a block</p> <p><u>For ICOORD = 2 or IMODE = 1</u></p> <p><math>M_{22}</math> Node number defining origin of spherical coordinate for ICOORD = 2, or node number defining reference origin to the whole volume for IMODE = 1</p> <p><u>For ICOORD = 3</u></p> <p><math>M_{22}</math> Node number defining reference origin of cylindrical coordinate.  <math>M_{23}</math> Node number defining cylinder axis <math>M_{22}-M_{23}</math>  <math>M_{24}</math> Node number defining other local axis <math>M_{22}-M_{24}</math> which is normal to cylinder axis.</p>





**Note: Mesh Control Data on File DV-GP.DAT**

To control mesh generation, users can change the values in file DV-GP.DAT in the directory C:\SMAP\CT\CTDATA.

1. Variables Controlling Coincident Nodes

RLIMIT

When the distance between two adjacent nodes is less than RLIMIT, those two nodes are assumed to be coincident.

2. Variables Controlling Spherical Coordinate

SDCLOSE, SDTOL, SDZERO

When the angle of block corner node reaches SDCLOSE (degree), program will set 360 degrees. The tolerance angle is SDTOL (degree). When the angle of block corner node is greater than (360-SDZERO), program will set zero degree.

3. Variables Controlling Cylindrical Coordinate

CDCLOSE, CDTOL, CDZERO

When the angle of block corner node reaches CDCLOSE (degree), program will set 360 degrees. The tolerance angle is CDTOL (degree). When the angle of block corner node is greater than (360-CDZERO), program will set zero degree.

4. For spherical block having the angle of longitude greater than  $\pi$  and for the cylindrical block occupying more than two quadrants, the block node numbers referring to the origin should be prefixed by negative sign.

5. Current Default Values

RLIMIT = 0.001

SDCLOSE = 359.1    SDTOL = 0.001    SDZERO = 0.001

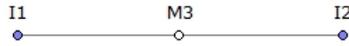
CDCLOSE = 359.1    CDTOL = 0.001    CDZERO = 0.001

**Note: Boundary Conditions**

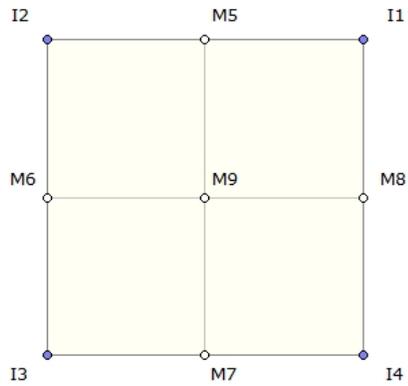
Boundary conditions at nodes are generated based on following rules:

1. Default conditions are applied first based on block type
2. Default conditions can be overridden by specifying IBTYPE = 1
3. Higher IBTYPE overrides lower IBTYPE in a given block
4. Each block number defined later governs conditions along the block interface

Line Block



Quad Surface Block



Triangle Surface Block

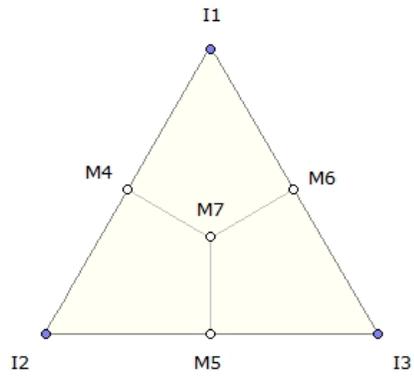


Figure 7.22 Block index for PRESMAP-GP

Hexahedron Volume Block

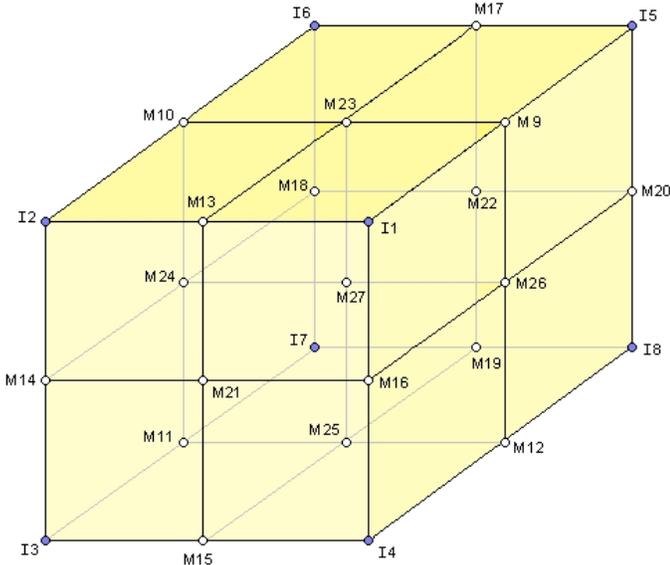


Figure 7.22 Block index for PRESMAP-GP (Continued)

Prism Volume Block

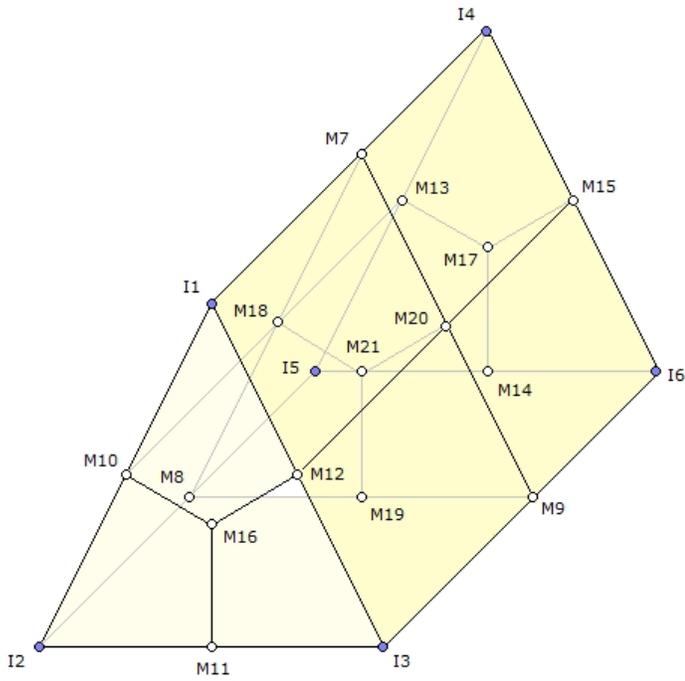


Figure 7.22 Block index for PRESMAP-GP (Continued)

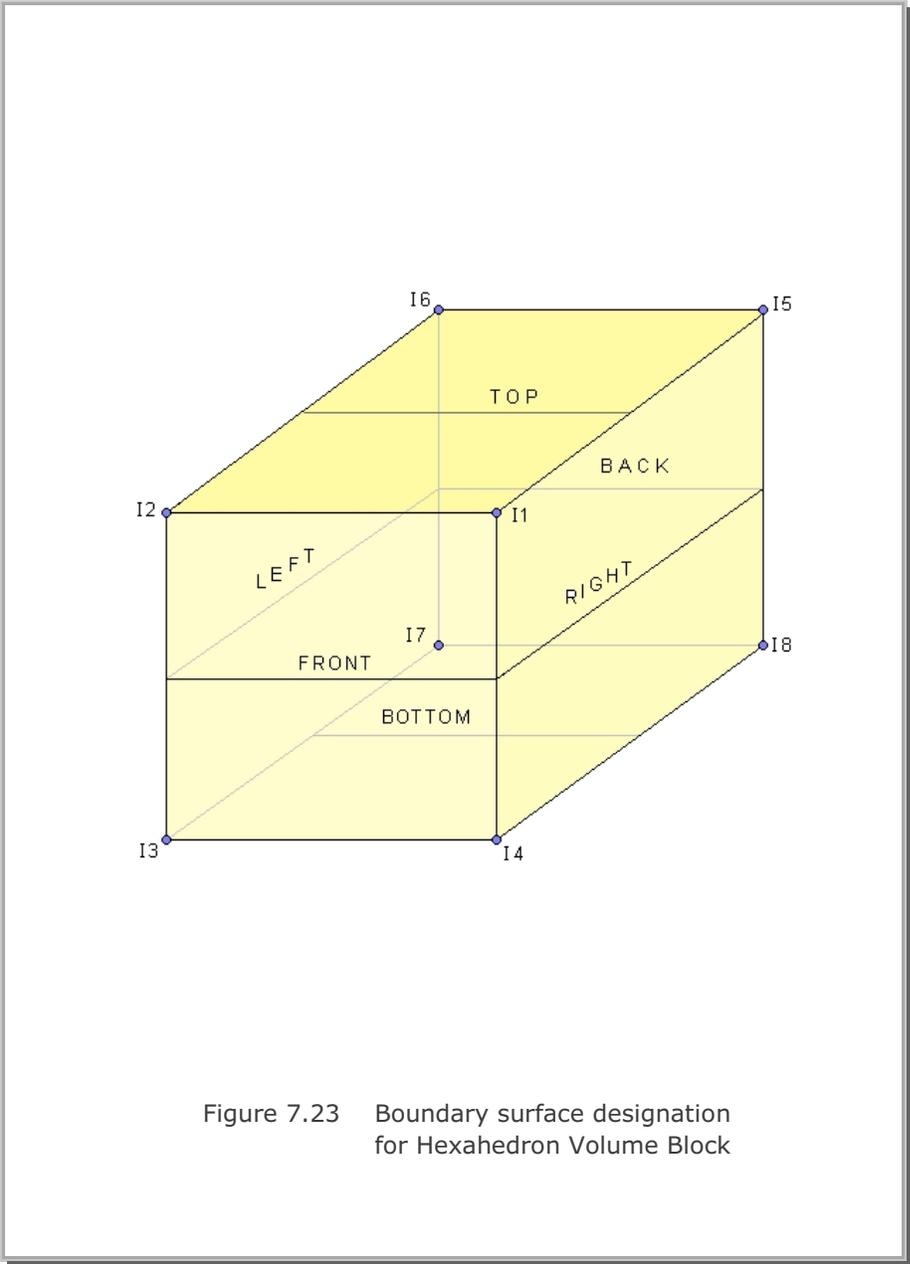


Figure 7.23 Boundary surface designation for Hexahedron Volume Block

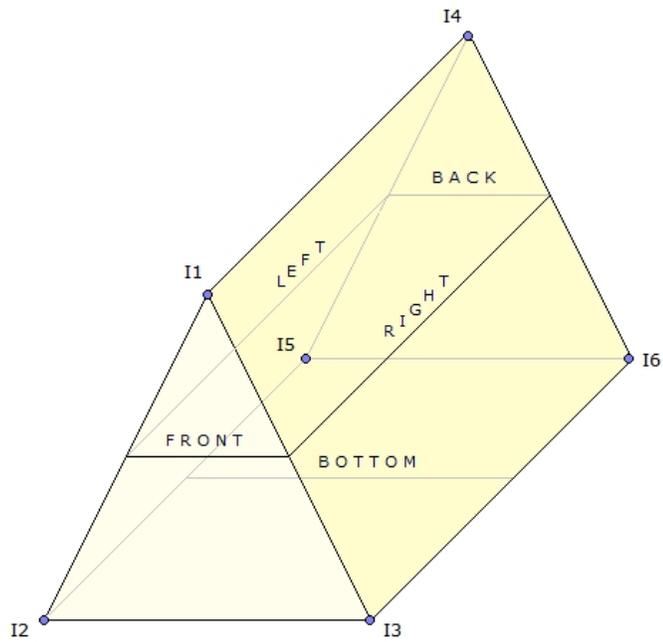


Figure 7.24 Boundary surface designation for Prism Volume Block

# ADDRGN User's Manual

## 8.1 Introduction

ADDRGN is the pre-processing program which has the following two basic functions:

- Combine two different meshes
- Modify existing meshes

A problem geometry can be composed of a number of regions.

Parts of the problem geometry can be generated using the PRESMAP programs described in Section 7. Then ADDRGN is used to combine two different regions (Region A and Region B). When Region B is added to Region A to make Combined Region, following restrictions are applied:

- Element numbers for Region A and Region B should be continuous
- Only those node numbers for Region B are modified to be consistent with the Region A, but element numbers for both regions do not change.

Though the program ADDRGN combines only two regions at a time, users can apply ADDRGN many times to assemble all the different regions.

ADDRGN can also be used to modify the existing meshes:

- Change coordinates
- Change boundary codes
- Cut elements
- Change material numbers

ADDRGN-2D deals with two dimensional meshes and ADDRGN-3D deals with three dimensional meshes.

ADDRGN-2D has an additional powerful feature which is very useful to generate meshes for complicated underground structures. This special feature modifies the existing meshes such that new structures can be easily added by simply specifying the geometries and material properties of structures. It can even generate a base mesh and then add new structures (IMOD=2).

ADDRGN-2D  
User's Manual



Card Group	Input Data and Definitions
<p>1</p> <p style="text-align: center;">Mode Type</p>	<p>1.1</p> <p>IMOD, JK</p> <p>IMOD = 0 Add Region B to Region A            = 1 Modify existing mesh            = 2 Generate base mesh and then modify.            Generated base mesh is saved as <b>Bmesh.dat</b>            = 3 Generate earth dam mesh: <b>EarthDam.Meg</b>            = -1 Same as IMOD = 0 except it uses DOF of Region B mesh along the interface</p> <p>JK            1 (T2), 2 (S2), 3 (2D), 9 (W2)</p>
<p>2</p> <p style="text-align: center;">Adding Region B to Region A (IMOD = 0)</p>	<p>2.1</p> <p>FILEA            FILEB            FILEC</p> <p>FILEA Input file name containing Region A mesh            FILEB Input file name containing Region B mesh            FILEC Output file name to store Combined Region mesh</p> <p>When combining Region B mesh to Region A mesh, only Region B node numbers are changed. Element numbers for Region A and Region B should be continuous, otherwise element numbers are automatically reordered by program.</p> <p>2.2</p> <p>INTERFACE</p> <p>INTERFACE = 0 Interface is found automatically            = 1 Interface is specified by user</p> <p>2.3</p> <p><b>Required only for INTERFACE = 1</b></p> <p>NODE</p> <p>NODA<sub>1</sub>, NODA<sub>2</sub>, ..., NODA<sub>NODE</sub>            NODB<sub>1</sub>, NODB<sub>2</sub>, ..., NODB<sub>NODE</sub></p> <p>NODE        Number of interface nodes.            NODA<sub>i</sub>      Interface node numbers in Region A            NODB<sub>i</sub>      Interface node numbers in Region B</p> <p><b>Note:</b> NODB<sub>i</sub> should be the same location as NODA<sub>i</sub></p>



Card Group	Input Data and Definitions	
<p>3</p> <p style="text-align: center;">Modifying Existing Mesh (IMOD = 1)</p>	<p style="text-align: center;">Changing Coordinates (IEDIT = 0)</p>	<p>3.3.1.1</p> <p><math>X_o, Y_o, X_{oNew}, Y_{oNew}</math></p> <p><math>X_o, Y_o</math>            Reference origin  <math>X_{oNew}, Y_{oNew}</math>    New origin</p> <hr/> <p>3.3.1.2</p> <p><math>X_{scale}, Y_{scale}</math></p> <p><math>X_{scale}, Y_{scale}</math>        Scale factors for X, Y coordinates</p> <p><b>Note:</b> New coordinates <math>X_{(new)}</math> and <math>Y_{(new)}</math> are computed as follows:</p> $X_{(new)} = X_{oNew} + (X - X_o) X_{scale}$ $Y_{(new)} = Y_{oNew} + (Y - Y_o) Y_{scale}$



Card Group	Input Data and Definitions	
<p>3</p> <p style="text-align: center;">Modifying Existing Mesh (IMOD = 1)</p>	<p style="text-align: center;">Cutting Elements (IEDIT = 2)</p>	<p>3.3.3.1</p> <p><b>IRANGE</b></p> <p style="margin-left: 40px;">IRANGE = 0 Range specified by coordinates                      = 1 Range specified by element numbers</p> <hr/> <p>3.3.3.2.1</p> <p style="color: blue;">Required only for IRANGE = 0</p> <p><math>X_{start}, Y_{start}, X_{end}, Y_{end}</math></p> <p style="margin-left: 40px;"><math>X_{start}, Y_{start}</math> Coordinates for lower left boundary  <math>X_{end}, Y_{end}</math> Coordinates for upper right boundary</p> <hr/> <p>3.3.3.2.2</p> <p style="color: blue;">Required only for IRANGE = 1</p> <p><b>NOEL</b></p> <p><math>NEL_1, NEL_2, \dots, NEL_{NOEL}</math></p> <p style="margin-left: 40px;">NOEL Number of elements to be specified                      NEL<sub>i</sub> Element number (See Note 2)</p> <hr/> <p>3.3.3.3</p> <p><b>INSIDE</b></p> <p style="margin-left: 40px;">INSIDE = 0 Apply inside of range                      = 1 Apply outside of range</p> <p style="margin-left: 40px;">Note 1: <math>NOD_1, -NOD_2</math> generates from <math>NOD_1</math> to <math>NOD_2</math>                      Note 2: <math>NEL_1, -NEL_2</math> generates from <math>NEL_1</math> to <math>NEL_2</math></p>





Card Group	Input Data and Definitions	
Modifying Existing Mesh (IMOD = 1)	Build User-Defined Curves and Material Zones (IEDIT = 4)	<p>3.3.5.4.1</p> <p>                     GTITL (For IGITL= 1)                      MTYPE, IGPOST, OVERLAY, GCOLOR,                      GLTYPE, GLTHIC, GHIDE                 </p> <p>GTITL Group title</p> <p>MTYPE</p> <ul style="list-style-type: none"> <li>= 1 Generate lines &amp; remove within closed loop</li> <li>= -1 Remove elements outside closed loop</li> <li>= 2 Generate lines</li> <li>= -2 Generate slip lines with joint elements</li> <li>= 3 Assign new material number within the closed loop</li> <li>= -3 Assign new material number within the closed loop and generate slip lines with joint elements along the loop.</li> </ul> <p>                     MTYPE = 4 and -4 are the same as MTYPE=3 and -3, respectively, except that old material zone is not removed for MTYPE = 4 and -4.                 </p> <p>To make the group null, use MTYPE = 0.</p> <p>IGPOST Generate Post file for element activity (1)</p> <p>OVERLAY Overlaid over existing group mesh (1)</p> <p>GCOLOR Group color index number</p> <p>GLTYPE Group line type index number</p> <p>GLTHIC Group line thickness index number</p> <p>GHIDE Group hide (1)</p>

Card Group	Input Data and Definitions	
Modifying Existing Mesh (IMOD = 1)	Build User-Defined Curves and Material Zones (IEDIT = 4)	<p>3.3.5.4.1</p> <p><u>For MTYPE = 1 or MTYPE = 2</u></p> <p>LTP, LMAT</p> <p><u>For MTYPE = -2</u></p> <p>MATNO<sub>JT'</sub>, DD<sub>JT'</sub>, THIC<sub>JT'</sub>, LTP<sub>I'</sub>, LMAT<sub>I'</sub>, LTP<sub>O'</sub>, LMAT<sub>O'</sub></p> <p><u>For MTYPE = 3</u></p> <p>MATNO, DD, LTP, LMAT</p> <p><u>For MTYPE = -3</u></p> <p>MATNO, DD, MATNO<sub>JT'</sub>, DD<sub>JT'</sub>, THIC<sub>JT'</sub>, LTP<sub>I'</sub>, LMAT<sub>I'</sub>, LTP<sub>O'</sub>, LMAT<sub>O'</sub></p> <p><u>For MTYPE = 4</u></p> <p>MATNO, DD, LTP, LMAT, MATold</p> <p><u>For MTYPE = -4</u></p> <p>MATNO, DD, MATNO<sub>JT'</sub>, DD<sub>JT'</sub>, THIC<sub>JT'</sub>, LTP<sub>I'</sub>, LMAT<sub>I'</sub>, LTP<sub>O'</sub>, LMAT<sub>O'</sub>, MATold</p> <p>                     DD = KF (SMAP-2D)                      = DEN (SMAP-S2)                      = IDH (SMAP-T2/W2)                 </p> <p>                     DD<sub>JT'</sub> = KF<sub>JT'</sub> (SMAP-2D)                      = DEN<sub>JT'</sub> (SMAP-S2)                      = IDH<sub>JT'</sub> (SMAP-T2/W2)                 </p> <p>                     For MTYPE = 4 or -4                      MATold takes initial value if MATNO &lt; 0                      MATold takes MATNO + 1 if MATold = 0                 </p>

Card Group	Input Data and Definitions	
Modifying Existing Mesh (IMOD = 1)	Build User-Defined Curves and Material Zones (IEDIT = 4)	<p style="text-align: center;">For Each Curve Group</p> <p>3.3.5.4.1</p> <p>MATNO            Material No for continuum element                      MATold            Additional MATNO for <b>MTYPE</b> = 4 or -4</p> <p>KF            = 0    Material has fluid phase                      = 1    Material has no fluid phase</p> <p>DEN            Unit weight                      IDH            Heat/Water generation ID</p> <p>MATNO<sub>JT</sub>            Material No for joint element</p> <p>KF<sub>JT</sub>            = 0    Joint has fluid phase                      = 1    Joint has no fluid phase</p> <p>DEN<sub>JT</sub>            Unit weight for joint element                      IDH<sub>JT</sub>            Heat generation ID for joint element</p> <p>THIC<sub>JT</sub>            Apparent thickness of joint element</p> <p>LTP = 0    Do not generate                      = 2    Generate beam element                                Heat pipe (IDFNP=LFUN), <b>T2</b>                      = 3    Generate truss element                                Convection (IDFNC=LFUN, IDFNT=LFUN+1), <b>T2</b>                      = 4    External flow (ID=0, IDF=LFUN), <b>T2/W2</b>                      = 5    Temper / Head bnd. (ID=1, IDF=LFUN), <b>T2/W2</b></p> <p>LMAT            Material No for line element                      LTP<sub>i</sub>, LMAT<sub>i</sub>        Subscript i refers to inner face                      LTP<sub>o</sub>, LMAT<sub>o</sub>        Subscript o refers to outer face</p> <p><b>Note:</b> For negative value of <b>LTP</b>, line elements take nodes in opposite face of joint element</p> <p>For negative value of THIC<sub>JT</sub>, joint elements are fully connected to the surrounding continuum elements (MTYPE = -2 or -3)</p>

Card Group	Input Data and Definitions	
Modifying Existing Mesh (IMOD = 1)	Build User-Defined Curves and Material Zones (IEDIT = 4)	<p>3.3.5.4.1</p> <p><u>Required only for IGPOST= 1</u></p> <p>NAC, NDAC (MATold)</p> <p>NAC, NDAC (MATNO)</p> <p>NAC, NDAC (MATNO<sub>JT</sub>)</p> <p>NAC, NDAC (LMAT)</p> <p>NAC, NDAC (LMAT<sub>I</sub>)</p> <p>NAC, NDAC (LMAT<sub>o</sub>)</p> <p>NAC Active step number</p> <p>NDAC Deactive step number</p> <p><u>Required only for IGPOST= 1</u></p> <p>CHKBOX (Mesh)</p> <p>CHKBOX (Principal Stress)</p> <p>CHKBOX (Deformed Shape)</p> <p>CHKBOX (Beam)</p> <p>CHKBOX (Truss)</p> <p>CHKBOX (Contour)</p> <p>CHKBOX (Reference Line)</p> <p>CHKBOX = 0 Do not plot</p> <p>= 1 Plot the checked item</p> <p><b>Note:</b> IGPOST= 1 will generate main file <b>Group.man</b> for element activity and post file <b>Group.pos</b> for PLOT-2D</p>

Card Group	Input Data and Definitions							
<p>3</p> <p style="text-align: center;">Modifying Existing Mesh (IMOD = 1)</p>	<p style="text-align: center;">Build User-Defined Curves and Material Zones (IEDIT = 4)</p>	<p style="text-align: center;">For Each Curve Group</p> <p>3.3.5.4.2</p> <p>NPOINT, MOVE, IREF, <math>X_{Lo}</math>, <math>Y_{Lo}</math></p> <p>NPOINT      Number of points defining X and Y coordinates of segments. Point numbering is counter-clockwise</p> <p>MOVE = 0      Generated coordinates are movable          = 1      Generated coordinates are not movable</p> <p>IREF = 0      Do not apply          = 1      Local Origin (<math>X_{Lo}</math>, <math>Y_{Lo}</math>) is relative to Reference Point in Card 3.3.5.4</p> <p><math>X_{Lo}</math>, <math>Y_{Lo}</math>      Coordinates of Local Origin</p> <table style="margin-left: 40px;"> <tr> <td rowspan="4" style="vertical-align: middle;">NPOINT Cards</td> <td rowspan="4" style="font-size: 2em; vertical-align: middle;">[</td> <td>NP<sub>1r</sub> X<sub>1r</sub> Y<sub>1</sub></td> </tr> <tr> <td>NP<sub>2r</sub> X<sub>2r</sub> Y<sub>2</sub></td> </tr> <tr> <td>-      -      -</td> </tr> <tr> <td>-      -      -</td> </tr> </table> <p>NP      Point number          X      X-coordinate          Y      Y-coordinate</p>	NPOINT Cards	[	NP <sub>1r</sub> X <sub>1r</sub> Y <sub>1</sub>	NP <sub>2r</sub> X <sub>2r</sub> Y <sub>2</sub>	-      -      -	-      -      -
NPOINT Cards	[	NP <sub>1r</sub> X <sub>1r</sub> Y <sub>1</sub>						
		NP <sub>2r</sub> X <sub>2r</sub> Y <sub>2</sub>						
		-      -      -						
		-      -      -						

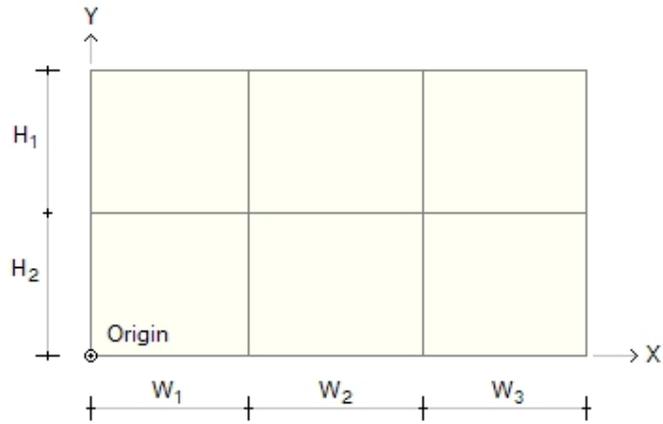


Card Group	Input Data and Definitions	
3  Modifying Existing Mesh (IMOD = 1)	Scale Buile-in Right Triangle (IEDIT = 5)	<p>3.3.6.1</p> <p>MODEL</p> <p>Select built-in right triangle model</p> <p>MODEL = 1 Slope 1:1 (L_1.0.Mes)                      = 2 Slope 1.5:1 (L_1.5.Mes)                      = 3 Slope 2:1 (L_2.0.Mes)                      = 4 Slope 2.5:1 (L_2.5.Mes)                      = 5 Slope 3:1 (L_3.0.Mes)</p> <p>Built-in right triangles are found in the directory:  <a href="c:\Smap\Ct\Ctdata\Slope">c:\Smap\Ct\Ctdata\Slope</a></p>
		<p>3.3.6.2</p> <p>MATNO, rHw, Hi</p> <p>MATNO Material number                      rHW Ratio of water level to dam height                      Hi Initial total head (Used for SMAP-W2)</p>
		<p>3.3.6.3</p> <p>Coordinates of new triangle</p> <p><math>X_{1r}</math> <math>Y_{1r}</math> <math>X_{2r}</math> <math>Y_{2r}</math> <math>X_{3r}</math> <math>Y_3</math></p> <p><math>X_{1r}</math> <math>Y_1</math> Top corner  <math>X_{2r}</math> <math>Y_2</math> Bottom left corner  <math>X_{3r}</math> <math>Y_3</math> Bottom right corner</p>









In this example, NBX=3 and NBY=2

Figure 8.1 Layout of Base Mesh

Case	$\theta_b$	$\theta_e$
1	30 °	310 °
2	310 °	30 °
3	-50 °	30 °
4	30 °	-50 °

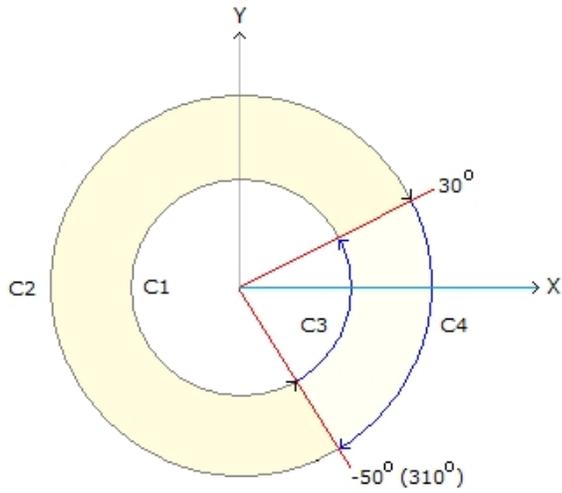


Figure 8.2 Examples of arc specification

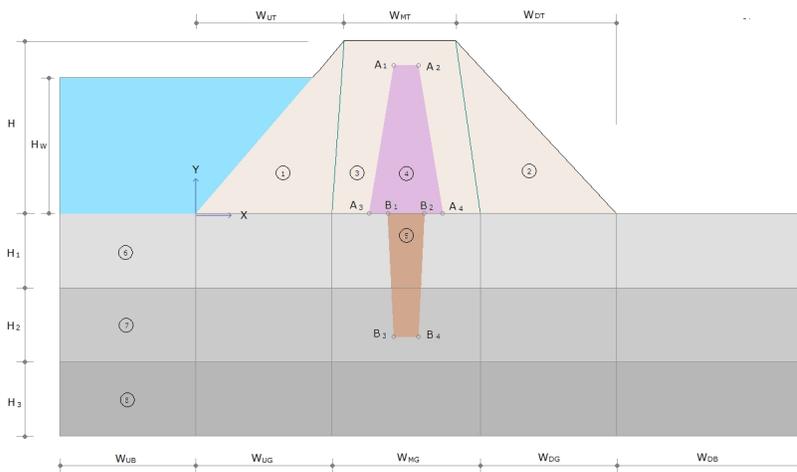


Figure 8.3 Schematic section view of earth dam

ADDRGN-3D  
User's Manual



Card Group	Input Data and Definitions
<p>1</p> <p>IMOD Type</p>	<p>1.1</p> <p>IMOD</p> <p>IMOD = 0 Add Region B to Region A            = 1 Modify existing mesh            = -1 Same as <b>IMOD</b> = 0 except it uses            DOF of Region B mesh along the interface</p>
<p>Adding Region B to Region A (IMOD = 0)</p>	<p>2.1</p> <p>FILEA            FILEB            FILEC</p> <p>FILEA Input file name containing Region A mesh            FILEB Input file name containing Region B mesh            FILEC Output file name to store Combined Region mesh</p> <p><b>Note:</b> When combining Region B mesh to Region A mesh, only Region B node numbers are changed. Element numbers for Region A and Region B should be continuous, otherwise element numbers are reordered automatically by program.</p>



Card Group	Input Data and Definitions	
<p>3</p> <p style="text-align: center;">Modifying Existing Mesh (IMOD = 1)</p>	<p style="text-align: center;">Changing Coordinates (IEDIT = 0)</p>	<p>3.3.1.1</p> <p><math>X_{o,r}</math> <math>Y_{o,r}</math> <math>Z_{o,r}</math> <math>X_{oNew,r}</math> <math>Y_{oNew,r}</math> <math>Z_{oNew,r}</math></p> <p><math>X_{o,r}</math> <math>Y_{o,r}</math> <math>Z_o</math>      Reference origin  <math>X_{oNew,r}</math> <math>Y_{oNew,r}</math> <math>Z_{oNew}</math>      New origin</p> <hr/> <p>3.3.1.1</p> <p><math>X_{scale,r}</math> <math>Y_{scale,r}</math> <math>Z_{scale,r}</math></p> <p><math>X_{scale,r}</math> <math>Y_{scale,r}</math> <math>Z_{scale,r}</math>      Scale factors for X,Y, and Z coordinates.</p> <p><b>Note:</b> New coordinates <math>X_{(new)}</math>, <math>Y_{(new)}</math>, <math>Z_{(new)}</math> are computed as follows:</p> $X_{(new)} = X_{oNew} + (X - X_o) X_{scale}$ $Y_{(new)} = Y_{oNew} + (Y - Y_o) Y_{scale}$ $Z_{(new)} = Z_{oNew} + (Z - Z_o) Z_{scale}$

Card Group	Input Data and Definitions	
<p>3</p> <p style="text-align: center;">Modifying Existing Mesh (IMOD = 1)</p>	<p style="text-align: center;">Changing Boundary Codes (IEDIT = 1)</p>	<p>3.3.2.1</p> <p><b>IRANGE</b></p> <p style="text-align: right; color: blue;">Range specified by</p> <p>IRANGE = 0 Coordinates            = 1 Node numbers            = 2 Polygon            = 3 Plane            = 4 Line strip            = 5 Material numbers</p> <hr/> <p>3.3.2.2.1</p> <p style="color: blue;">Required only for IRANGE = 0</p> <p><math>X_{start}, Y_{start}, Z_{start}, X_{end}, Y_{end}, Z_{end}</math></p> <p><math>X_{start}, Y_{start}, Z_{start}</math> Coordinates for lower left boundary  <math>X_{end}, Y_{end}, Z_{end}</math> Coordinates for upper right boundary</p> <hr/> <p>3.3.2.2.2</p> <p style="color: blue;">Required only for IRANGE = 1, 2, 3, 4, 5</p> <p><b>NODE</b></p> <p><math>NOD_1, NOD_2, \dots, NOD_{NODE}</math></p> <p>NODE Number of nodes/materials to be specified  <math>NOD_i</math> Node/Material number (See Note 1)</p> <p>Polygon (IRANGE = 2) is defined counterclockwise            Plane (IRANGE = 3) is defined by 3 nodes</p> <p>For IRANGE = 5, Nodes refer to Material numbers.</p> <p>Note 1: <math>NOD_1, -NOD_2</math> generates from <math>NOD_1</math> to <math>NOD_2</math>            Note 2: <math>NEL_1, -NEL_2</math> generates from <math>NEL_1</math> to <math>NEL_2</math></p>













## Supplement Program

### 9.1 Introduction

Supplement programs contain supporting programs which are useful to prepare input data for pre-and main-processing programs and can be accessed through **Run** → **Mesh Generator** → **Supplement** menu.

Currently, there are five programs available:  
EDIT, XY, CARDS, SHRINK FILE and CUDSS.

**EDIT** is used to run text editor.

**XY** computes coordinates of mid points, cross points, or normal points.

**CARDS** generates **Element Activity** data in Card Group 8 in Section 4.4 Main File.

**SHRINK FILE** removes extra blank spaces before carriage return. This will reduce the size of the file.

**CUDSS** simulates cyclic undrained direct simple shear test.

### 9.2 EDIT

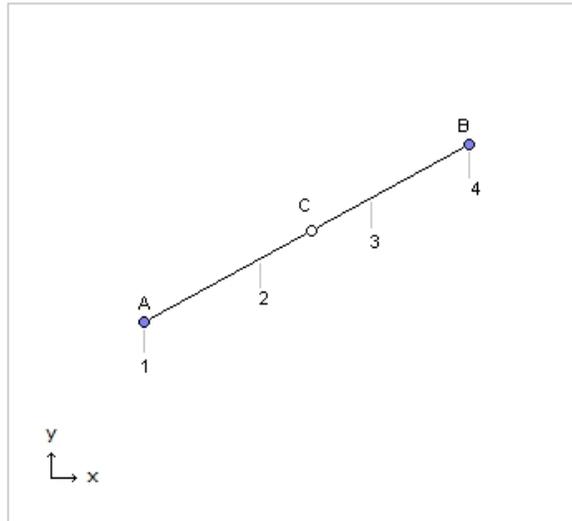
EDIT uses Windows text editor **Wordpad** to creat, modify, or list file.

### 9.3 XY

Program **XY** can be used to compute midpoints, intersection points and normal points of straight line and circular arc. The program is useful to construct the block diagrams of the problem geometry.

To run program XY, simply select **XY** from **SUPPLEMENT** Menu and follow instructions shown on the screen.

NF = 1 Compute Midpoint on Straight Line



Example: NDIV = 3 and ALPHA = 0.5

INPUT:

XA, YA, XB, YB

NDIV, ALPHA

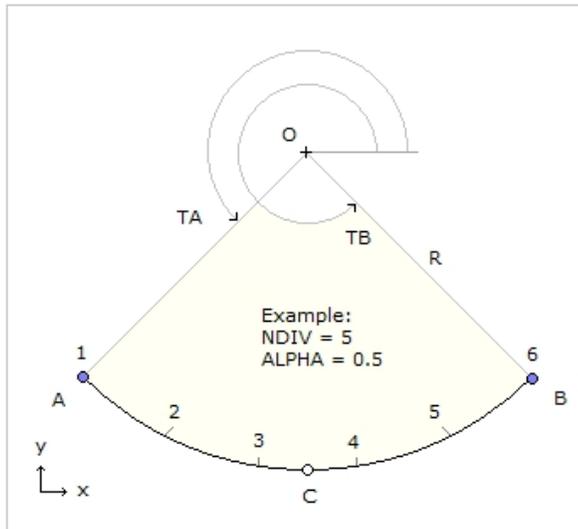
XA, YA = X and Y coordinates of A

XB, YB = X and Y coordinates of B

NDIV = Number of division

ALPHA = Geometric ratio

NF = 2 Compute Midpoint on Circular Arc



INPUT:

$R,$   $X_o,$   $Y_o,$   $TA,$   $TB$   
 $NDIV,$   $ALPHA$

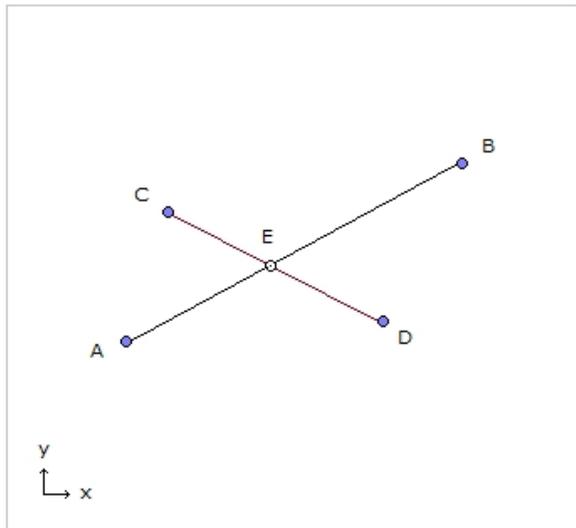
$R$  = Radius  
 $X_o, Y_o$  = X and Y coordinates of origin O  
 $TA, TB$  = Angles (degrees) of A and B  
 $NDIV$  = Number of division  
 $ALPHA$  = Geometric ratio

If  $ALPHA = 0.5$ , midpoint C is located in half way between A and B

If  $ALPHA < 0.5$ , midpoint is close to A

If  $ALPHA > 0.5$ , midpoint is close to B

NF = 3    Compute Intersection Point of Two Straight Lines

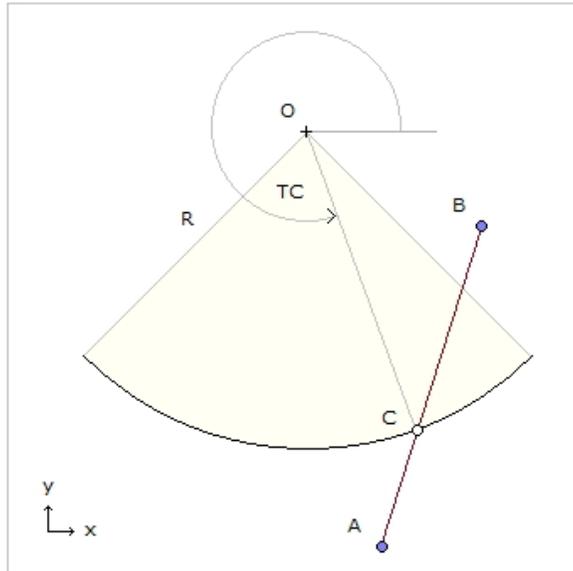


INPUT:

XA, YA, XB, YB  
XC, YC, XD, YD

XA, YA = X and Y coordinates of A  
XB, YB = X and Y coordinates of B  
XC, YC = X and Y coordinates of C  
XD, YD = X and Y coordinates of D

NF = 4 Compute Intersection point of Arc & Straight Line

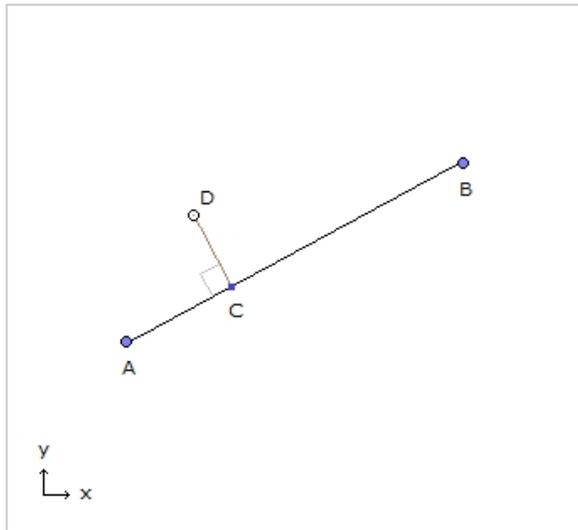


INPUT:

$R,$   $X_o,$   $Y_o$   
 $X_A,$   $Y_A,$   $X_B,$   $Y_B$

$R$  = Radius  
 $X_o,$   $Y_o$  = X and Y coordinates of origin O  
 $X_A,$   $Y_A$  = X and Y coordinates of point A  
 $X_B,$   $Y_B$  = X and Y coordinates of point B

NF = 5 Compute Points Normal to Straight Line

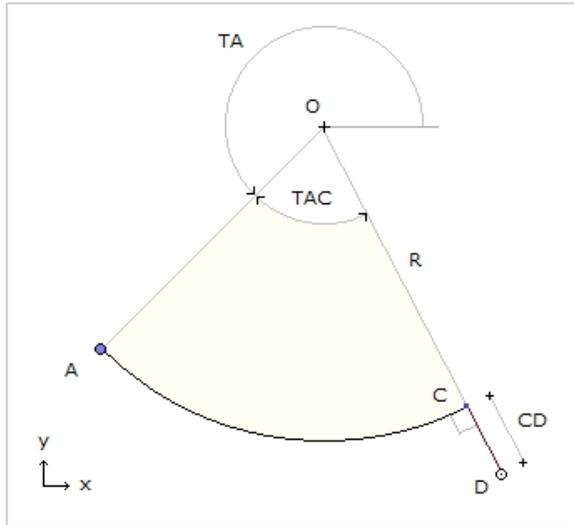


INPUT:

XA, YA, XB, YB  
AC, CD

XA, YA = X and Y coordinates of A  
XB, YB = X and Y coordinates of B  
AC = Distance between A and C  
CD = Distance between C and D

NF = 6 Compute Points Normal to Circular Arc



INPUT:

$R,$   $X_o,$   $Y_o,$   $TA$   
 $TAC,$   $CD$

$R$  = Radius  
 $X_o, Y_o$  = X and Y coordinates of origin O  
 $TA$  = Angle (degree) of A  
 $TAC$  = Angle (degree) between A and C  
 $CD$  = Distance between C and D

#### 9.4 CARDS

Program CARDS is included to aid for users to prepare SMAP-3D input cards. Currently, there is only one routine which generates Element Activity in Card Group 8 in Section 4.4 Main File.

You are asked to type in following input data to generate element activity and deactivity;

NEL (start) NEL(end) NAC NDAC

where

NEL (start)	Starting element number
NEL (end)	Ending element number
NAC	Load step at which elements from NEL(start) to NEL(end) are activated.
NDAC	Load step at which elements from NEL(start) to NEL(end) are deactivated.

Generated element activity data will be written in the output file you specified.

#### 9.5 SHRINK FILE

SHRINK FILE is included to remove extra blank spaces before carriage return. This will reduce the size of the file where blank spaces are existing before the carriage return.

## File Conversion

### 10.1 Introduction

**PRESMAP** programs described in Section 7 generate Mesh Files which contain the geometric information of structures to be analyzed. The format of SMAP-W3 Mesh File is presented in detail in Section 4.3.

Three-dimensional Mesh Files can also be created by IGES (Initial Graphics Exchange Specification) or FEMAP (Version 4.1 - 4.5, neutral format) program which is developed by EDS.

In this section, we will briefly discuss Mesh File conversion under **Mesh Generator** → **File Conversion** menu:

### 10.2 Conversion to SMAP-W3 Mesh File

Following Mesh Files can be converted to SMAP-W3 Mesh File format:

- Mesh Files generated for two-dimensional SMAP programs (SMAP-S2, SMAP-2D, SMAP-T2 and SMAP-W2)
- Mesh Files generated for three-dimensional SMAP program (SMAP-T3 and SMAP-3D)
- IGES (Initial Graphics Exchange Specification)
- FEMAP (Version 4.1 - 4.5, neutral format)

Figure 10.1 shows File Conversion dialog box with Input Mesh File options.

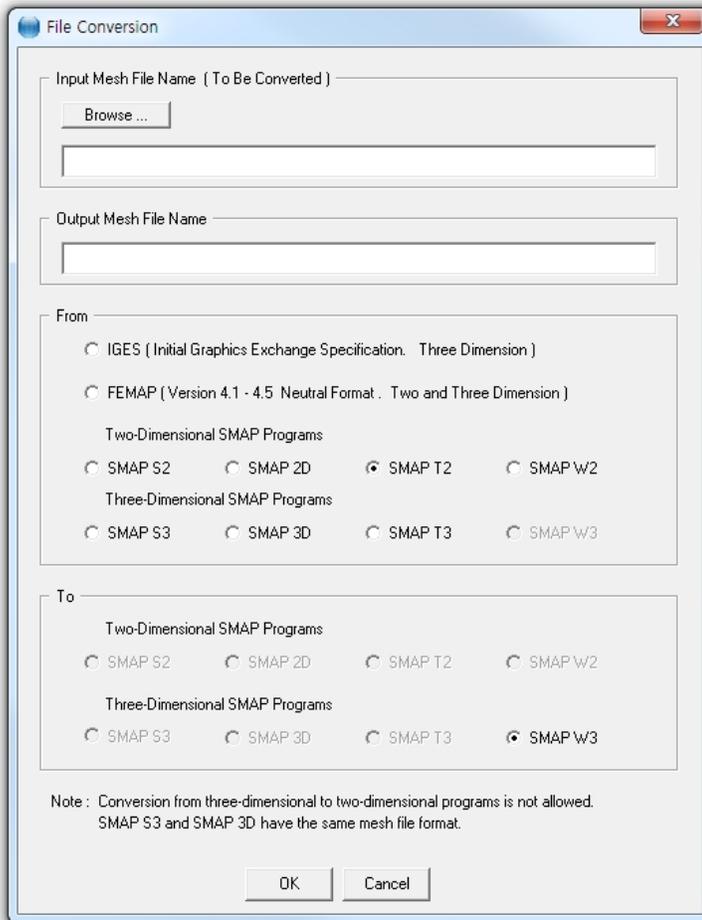


Figure 10.1 File Conversion dialog box

# **LOAD**

## **User's Manual**

### **11.1 Introduction**

LOAD is the pre-processing program which generates nodal values of external forces, specified velocities, initial velocities, accelerations and transmitting boundaries.

Before you prepare LOAD input data in this section, you should have a Mesh File generated from PRESMA/ADDRGN programs. That is, LOAD input is referred to the geometric surfaces given in the Mesh File.

Generated LOAD output file contains load data which is compatible to the format of Card Group 9 described in Section 4.4 Main File.

LOAD-2D deals with two dimensional meshes and LOAD-3D deals with three dimensional meshes.



LOAD-2D

LDTYPE = 7 [Seepage: SMAP-W2]



Card Group	Input Data and Definitions (Seepage)	
1  Title & Element	1.1	<p><b>TITLE</b>                      TITLE    Any title (Max = 60 characters)</p>
	1.2	<p><b>NCTYPE</b>                      NCTYPE = 0    Axisymmetric element                                        Y-axis is axis of symmetry                      = 1    Plane element (Thickness=1.0)</p>
2  Loading Surface	2.1	<p><b>NUMLS</b>                      NUMLS    Number of loading surfaces where hydraulic boundary conditions are specified (Max = 20)                      Loading surface is saved in <a href="#">LoadingSurface.out</a></p>
	2.2  For Each Loading Surface	<p>2.2.1  <b>LSNO, LSTYPE</b>                      LSNO    Loading surface number                      LSTYPE = 0    All specified nodes                                = 1    Line strip           = 2    Points                                = 3    Node group        = 4    Element group</p>
		<p>2.2.2  <b>NUMNODE</b>                      NUMNODE    Number of nodes on this loading surface (Max = 9990)</p>
	<p>LSTYPE = 0, 1, 2</p>	<p>2.2.3  <b>NOD<sub>1</sub>, NOD<sub>2</sub>, ..., NOD<sub>NUMNODE</sub></b>                      NOD<sub>i</sub>    Specified node                        Line strip (LSTYPE=1) is defined counterclockwise.                      For LSTYPE=1 and NOD<sub>NUMNODE</sub> &lt; 0, absolute value of NOD<sub>NUMNODE</sub> is the reference node defining normal.</p>

Card Group	Input Data and Definitions (Seepage)																																						
2	2.2	Loading Surface For Each Loading Surface LSTYPE = 3 (Node Group)	<p>2.2.4</p> <p><b>NUMNODG</b></p> <p>NUMNODG    Number of node groups on this loading surface (Max = 100)</p> <hr/> <p>2.2.5</p> <p>NSR, JCR, NJR, ICR, NIR    <b>For Each Group</b></p> <p>NSR    Starting node number of the first row            JCR    Node number increment in a row            NJR    Number of nodes in a row            ICR    Node number increment for next row            NIR    Total number of rows</p> <div style="display: flex; align-items: center; margin-top: 10px;"> <table style="border-collapse: collapse; margin-right: 20px;"> <tr><td style="padding: 0 10px;">5</td><td style="padding: 0 10px;">10</td><td style="padding: 0 10px;">15</td><td style="padding: 0 10px;">20</td></tr> <tr><td style="text-align: center;">○</td><td style="text-align: center;">○</td><td style="text-align: center;">○</td><td style="text-align: center;">○</td></tr> <tr><td colspan="4" style="text-align: center;">—</td></tr> <tr><td style="padding: 0 10px;">35</td><td style="padding: 0 10px;">40</td><td style="padding: 0 10px;">45</td><td style="padding: 0 10px;">50</td></tr> <tr><td style="text-align: center;">○</td><td style="text-align: center;">○</td><td style="text-align: center;">○</td><td style="text-align: center;">○</td></tr> <tr><td colspan="4" style="text-align: center;">—</td></tr> <tr><td style="padding: 0 10px;">65</td><td style="padding: 0 10px;">70</td><td style="padding: 0 10px;">75</td><td style="padding: 0 10px;">80</td></tr> <tr><td style="text-align: center;">○</td><td style="text-align: center;">○</td><td style="text-align: center;">○</td><td style="text-align: center;">○</td></tr> <tr><td colspan="4" style="text-align: center;">—</td></tr> </table> <div style="font-size: small;"> <p>Example</p> <p>NSR = 5            JCR = 5            NJR = 4            ICR = 30            NIR = 3</p> </div> </div>	5	10	15	20	○	○	○	○	—				35	40	45	50	○	○	○	○	—				65	70	75	80	○	○	○	○	—			
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—																																							
LSTYPE = 4 (Element Group)	<p>2.2.6</p> <p><b>NUMNELG</b></p> <p>NUMNELG    Number of element groups on this loading surface (Max = 100)</p> <hr/> <p>2.2.7</p> <p>NSR, JCR, NJR, ICR, NIR, NS    <b>For Each Group</b></p> <p>NSR    Starting element number of the first row            JCR    Element number increment in a row            NJR    Number of elements in a row            ICR    Element number increment for next row            NIR    Total number of rows            NS    Element surface number (See Mesh File Card 3.2)</p> <div style="display: flex; align-items: center; margin-top: 10px;"> <table border="1" style="border-collapse: collapse; margin-right: 20px; text-align: center;"> <tr><td>5</td><td>10</td><td>15</td><td>20</td></tr> <tr><td>35</td><td>40</td><td>45</td><td>50</td></tr> <tr><td>65</td><td>70</td><td>75</td><td>80</td></tr> </table> <div style="font-size: small;"> <p>Example</p> <p>NSR = 5            JCR = 5            NJR = 4            ICR = 30            NIR = 3</p> </div> </div>	5	10	15	20	35	40	45	50	65	70	75	80																										
5	10	15	20																																				
35	40	45	50																																				
65	70	75	80																																				

Card Group	Input Data and Definitions (Seepage)	
Loading Function	3	3.1 NUMLF  NUMLF    Number of loading functions (Max = 20)
	3.2	3.2.1 LFNO  LFNO    Loading function number
	For Each Loading Function	3.2.2 $a_0, a_1, a_2$  $a_i$ Coefficients defining loading function (F) $F = a_0 + a_1x + a_2y$







LOAD-3D

LDTYPE = 7 [See page: SMAP-W3]



Card Group	Input Data and Definitions (Seepage)	
1	1.1	<p><b>TITLE</b></p> <p>TITLE Any title (Max = 60 characters)</p>
2	2.1	<p><b>NUMLS</b></p> <p>NUMLS Number of loading surfaces where hydraulic boundary conditions are specified (Max = 20) Loading surface is saved in <a href="#">LoadingSurface.out</a></p>
	2.2	<p>2.2.1</p> <p><b>LSNO, LSTYPE</b></p> <p>LSNO Loading surface number</p> <p>LSTYPE = 0 All specified nodes                      = 1 Polygon                   = 2 Plane                      = 3 Line strip           = 4 Points                      = 5 Node group                      = 6 Element group</p>
	For Each Loading Surface LSTYPE = 0, 1, 2, 3, 4	<p>2.2.2</p> <p><b>NUMNODE</b></p> <p>NUMNODE Number of nodes on this loading surface (Max = 9990)</p> <hr/> <p>2.2.3</p> <p><b>NOD<sub>1</sub>, NOD<sub>2</sub>, ..., NOD<sub>NUMNODE</sub></b></p> <p>NOD<sub>i</sub> Specified node</p> <p>Polygon (LSTYPE=1) is defined counterclockwise.            Plane (LSTYPE=2) is defined by 3 nodes.            For LSTYPE=3 and NOD<sub>NUMNODE</sub> &lt; 0, absolute value of NOD<sub>NUMNODE</sub> is the reference node defining normal.</p>

Card Group	Input Data and Definitions (Seepage)																																								
2	Loading Surface	<p>2.2</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">For Each Loading Surface</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">LSTYPE = 5 (Node Group)</p> <div> <p>2.2.4</p> <p><b>NUMNODG</b></p> <p>NUMNODG    Number of node groups on this loading surface (Max = 100)</p> </div> <hr/> <div> <p>2.2.5</p> <p>NSR, JCR, NJR, ICR, NIR    <b>For Each Group</b></p> <p>NSR    Starting node number of the first row</p> <p>JCR    Node number increment in a row</p> <p>NJR    Number of nodes in a row</p> <p>ICR    Node number increment for next row</p> <p>NIR    Total number of rows</p> <div> <table style="display: inline-table; border: none;"> <tr> <td style="text-align: center;">5</td> <td style="text-align: center;">10</td> <td style="text-align: center;">15</td> <td style="text-align: center;">20</td> <td rowspan="3" style="vertical-align: middle; padding-left: 10px;">Example</td> </tr> <tr> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> </tr> <tr> <td colspan="4" style="text-align: center;">—</td> </tr> <tr> <td style="text-align: center;">35</td> <td style="text-align: center;">40</td> <td style="text-align: center;">45</td> <td style="text-align: center;">50</td> <td rowspan="3" style="vertical-align: middle; padding-left: 10px;">NSR = 5 JCR = 5 NJR = 4 ICR = 30 NIR = 3</td> </tr> <tr> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> </tr> <tr> <td colspan="4" style="text-align: center;">—</td> </tr> <tr> <td style="text-align: center;">65</td> <td style="text-align: center;">70</td> <td style="text-align: center;">75</td> <td style="text-align: center;">80</td> <td rowspan="3" style="vertical-align: middle; padding-left: 10px;"></td> </tr> <tr> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> </tr> <tr> <td colspan="4" style="text-align: center;">—</td> </tr> </table> </div> </div>	5	10	15	20	Example	○	○	○	○	—				35	40	45	50	NSR = 5 JCR = 5 NJR = 4 ICR = 30 NIR = 3	○	○	○	○	—				65	70	75	80		○	○	○	○	—			
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<p>2.2.6</p> <p><b>NUMNELG</b></p> <p>NUMNELG    Number of element groups on this loading surface (Max = 100)</p>																																									
<p>2.2.7</p> <p>NSR, JCR, NJR, ICR, NIR, NS    <b>For Each Group</b></p> <p>NSR    Starting element number of the first row</p> <p>JCR    Element number increment in a row</p> <p>NJR    Number of elements in a row</p> <p>ICR    Element number increment for next row</p> <p>NIR    Total number of rows</p> <p>NS    Element surface no. (See Mesh File Card 3.2)</p> <div> <table style="display: inline-table; border: none;"> <tr> <td style="text-align: center;">5</td> <td style="text-align: center;">10</td> <td style="text-align: center;">15</td> <td style="text-align: center;">20</td> <td rowspan="3" style="vertical-align: middle; padding-left: 10px;">Example</td> </tr> <tr> <td style="text-align: center;">35</td> <td style="text-align: center;">40</td> <td style="text-align: center;">45</td> <td style="text-align: center;">50</td> </tr> <tr> <td style="text-align: center;">65</td> <td style="text-align: center;">70</td> <td style="text-align: center;">75</td> <td style="text-align: center;">80</td> </tr> </table> <p style="margin-left: 20px;">NSR = 5 JCR = 5 NJR = 4 ICR = 30 NIR = 3</p> </div>	5	10	15	20	Example	35	40	45	50	65	70	75	80																												
5	10	15	20	Example																																					
35	40	45	50																																						
65	70	75	80																																						

Card Group	Input Data and Definitions (Seepage)	
Loading Function	3	<p>3.1</p> <p>NUMLF</p> <p>NUMLF    Number of loading functions (Max = 20)</p>
	3.2	<p>3.2.1</p> <p>LFNO</p> <p>LFNO    Loading function number</p>
	For Each Loading Function	<p>3.2.2</p> <p><math>a_0, a_1, a_2, a_3</math></p> <p><math>a_i</math>    Coefficients defining loading function (F)</p> <p><math>F = a_0 + a_1x + a_2y + a_3z</math></p>







## XY Graph User's Manual

### 12.1 Introduction

**XY Graph** is a two-dimensional graph consisting of lines connecting each pair of data points, which can be plotted by **PLOT XY** or **EXCEL**. Figure 12.1 shows schematic flow diagram of plotting simple form of **Draft XY** data in Table 12.1.

This **Draft XY** is changed into **Standard XY** by **Converter DS**. Then **Standard XY** can be plotted by directly **PLOT XY** or by **EXCEL** with the aid of **Converter SE**.

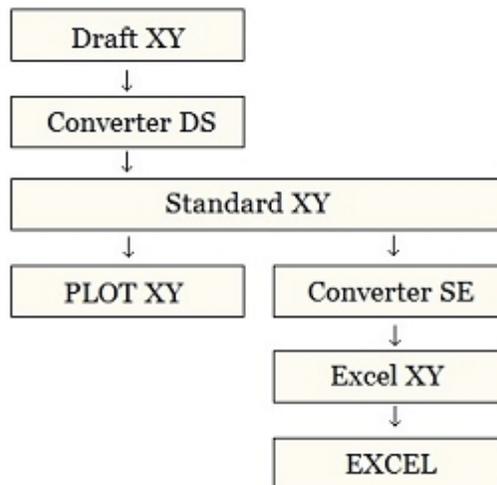


Figure 12.1 Flow diagram of plotting XY graph

Table 12.1 Draft XY Data Format

Card Group	Input Data and Definitions	
First Plot	Title	Title (Max 50 Characters) Sub Title (Max 50 Characters) X-Label (Max 50 Characters) Y-Label (Max 50 Characters)
	First Curve	$X_1$ $Y_1$ $X_2$ $Y_2$ - - $X_n$ $Y_n$ 0.0 123456 (End of Curve) Legend 1 (Max 20 Characters) Legend 2 (Max 20 Characters)
	Second Curve	$X_1$ $Y_1$ $X_2$ $Y_2$ - - $X_n$ $Y_n$ 0.0 123456 (End of Curve) Legend 1 (Max 20 Characters) Legend 2 (Max 20 Characters)
	Last Curve	$X_1$ $Y_1$ $X_2$ $Y_2$ - - 0.0 -123456 (End of Line Segment) $X_1$ $Y_1$ $X_2$ $Y_2$ - - $X_n$ $Y_n$ 0.0 123456 (End of Curve) Legend 1 (Max 20 Characters) Legend 2 (Max 20 Characters) 0.0 987654 (End of Plot)
Next Plot	Next Plot can be added using the same format as the First Plot	

## 12.2 New Graph

XY Graph can be created by performing the following steps:

### Step 1:

Select the following menu items in **SMAP**:

Plot → XY → PLOT XY → New

### Step 2:

Once selected, initial default file **XY.dat** will be opened by **Notepad** as listed in Table 12.2.

Edit this default file according to the format of **Draft XY Data** in Table 12.1. And then save and exit.

### Step 3:

**Draft XY.dat** is automatically changed into **Standard Form** by **Converter DS** as listed in Table 12.3.

Modified graph will be displayed on **PLOT XY** drawing board.

### Step 4:

XY Graph can be further modified by **Edit Dialog** explained in detail in the next Section 12.3.

Table 12.2 Draft XY Data (Initial Default File [XY.dat](#))

```
Plot No. 1
Sub Title 1
XLabel-1
YLabel-1
0 10
100 20
.000000E+00 .123456E+06
Curve 1
Legend
10, 20
90, 30
.000000E+00 .123456E+06
Curve 2
Legend
.000000E+00 .987654E+06
Plot No. 2
Sub Title 2
XLabel-2
YLabel-2
0 100
1000 200
.000000E+00 .123456E+06
Curve 1
Legend
100 200
900 300
.000000E+00 .123456E+06
Curve 2
Legend
.000000E+00 .987654E+06
Plot No. 3
Sub Title 3
XLabel-3
YLabel-3
0 100
1000 200
.000000E+00 .123456E+06
Curve 1
Legend
200, 200
900, 300
.000000E+00 .123456E+06
Curve 2
Legend
.000000E+00 .987654E+06
```

Table 12.3 Standard XY Data (Initial Default File [XY.dat](#))

```

*****
*                               PLOT NO: 1                               *
*****
C Following data can be modified for plotting configuration
  TITLE (50 CHAR) = Plot No. 1
  SUB-TITLE (50 CHAR) = Sub Title 1
  XLABLE (50 CHAR) = XLabel-1
  YLABLE (50 CHAR) = YLabel-1
C
MAN.-SCALE : IXY = 1
LEGEND-OPT. : ILG = 1
TOTAL CURVE : NLG = 2
LEGEND-LEN : DXLEGN = 0.0
C
C IELEM= 0: no list data, list X-label & X-tick number
C 1: list data, list X-label & X-tick number
C -2: node data, list node numbers only
C 2: element data, list element numbers only
C -3: node data, list node no, X-tick no. & X-label
C 3: element data, list elem no, X-tick no. & X-label
EL-LIST-OPT : IELEM = 0
C
FRAMING : IFM = 1
CENTERING : ICENL = 1
GRIDDING : IGRID = 1
C X-coordinate data
  XMAX = 5.0
  NODX = 6
  XS = .000000E+00
  XE = .120000E+03
  NXDEC = -1
  XSCALE = 1.0
C
  IGENX = 0
  XDELTA = 0.0
C
  LOGX = 0
  NXD = 0
C Y-coordinate data
  YMAX = 5.0
  NODY = 6
  YS = .800000E+01
  YE = .320000E+02
  NYDEC = 2
  YSCALE = 1.0
C
  LOGY = 0
  NYD = 0
C Individual Curve
C
  NO : 1 2 3 4 5 6 7 8 9 10
  HIDE = 0 0 0 0 0 0 0 0 0 0
  LINE = 1 1 1 1 1 1 1 1 1 1
  DASH = 1 2 3 4 5 6 7 8 9 10
  MARK = 1 2 3 4 5 6 7 8 9 10
  COLR = 1 2 3 4 5 6 7 8 9 10
C *****
.000000E+00 .100000E+02
.100000E+03 .200000E+02
.000000E+00 .123456E+06
Curve 1
Legend
.100000E+02 .200000E+02
.900000E+02 .300000E+02
.000000E+00 .123456E+06
Curve 2
Legend
.000000E+00 .987654E+06

```

### 12.3 Edit Dialog

**Edit Dialog** in Figure 12.2 can be accessed by selecting the **Edit** menu in **PLOT-XY**.

**Edit Dialog** consists of following six parts:

- Titles and Labels
- General Options
- Dimensions and Scales
- Manual Scales
- Curve Data
- Command Buttons & Check Box

Refer to description in **Sample Graph** in Figure 12.3.

Figure 12.2  
Edit dialog

The screenshot shows the 'Edit Dialog' for 'PLOT NO 1'. It is divided into several sections:

- Titles and Labels:** Contains text boxes for 'Title' (Example 1), 'Sub Title' (Stress History), 'X-Label' (Time (Sec)), and 'Y-Label' (Stress (MPa)).
- General Options:** Contains checkboxes for 'Framing', 'Gridding', 'Centering', 'Log X', and 'Log Y'. 'Framing', 'Gridding', and 'Centering' are checked.
- Dimensions and Scales:** Contains input fields for 'Xmax Cm' (2.69), 'Ymax Cm' (5.99), 'Dxlegn Cm' (0.00), 'Xscale' (1.0000), 'Yscale' (1.0000), and 'Xdelta' (0).
- Manual Scales:** Contains input fields for 'Xs' (0), 'Xe' (120.00), 'Nodx' (6), 'Nxdec' (-1), 'Ys' (8.0000), 'Ye' (32.000), 'Nody' (6), and 'Nydec' (2).
- Curve No 1:** Contains two dropdown menus, one set to '1: Mark & Line' and another to '1: Solid Line'. It also has buttons for 'Mark', 'Color' (with a blue color swatch), and a 'Legend' field containing 'Vertical' and 'Stress'. Below these are navigation buttons: '<', '>', 'List', 'Hide', 'Modify XY', 'Edit XY', 'Delete', and 'Add'.
- Bottom Section:** Contains buttons for 'Sample', 'Description', 'Add as New Plot' (with an unchecked checkbox), 'OK', and 'Cancel'.

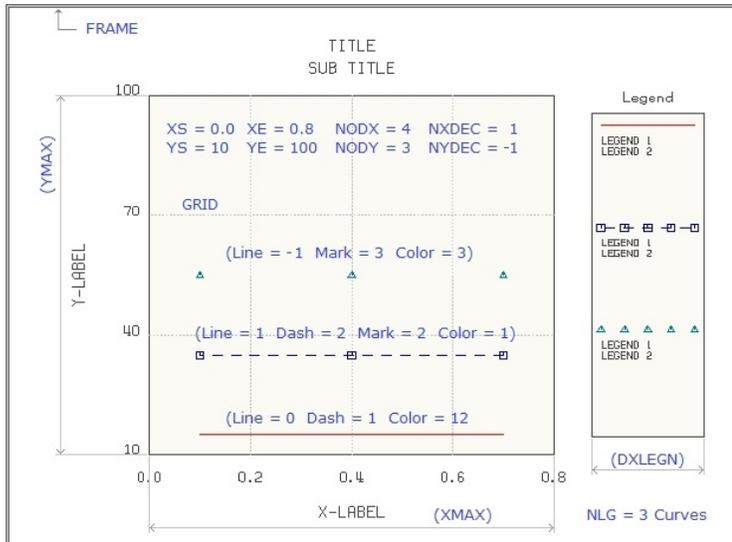


Figure 12.3 Sample graph

### 12.3.1 Titles and Labels

Here, you type:

Title, Sub Title, X-Label, and Y-Label.

### 12.3.2 General Options

Check the box for the option item to be active:

- Framing      Draw Frame
- Gridding     Draw Grid lines
- Centering    Center Titles and X & Y Labels
- Log X         Log scale in X axis
- Log Y         Log scale in Y axis

### 12.3.3 Dimensions and Scales

Refer to description in [Sample Graph](#) in Figure 12.3.

### 12.3.4 Manual Scales

Refer to description in [Sample Graph](#) in Figure 12.3.

### 12.3.5 Curve Data

For each curve, you can select [Line](#) type, [Dash](#) type, [Mark](#) type, [Color](#) as in Figure 12.4, and type in [Legends](#).

Check [Hide](#) to hide the current curve.

Figure 12.4  
Curve options



**Curve Data** has the following seven command buttons:

- Back**            Open previous curve
- Next**            Open next curve
- List**             List all curves as in Figure 12.5a
- Modify XY**        Modify current curve XY data as in Figure 12.5b
- Edit XY**          Edit current curve XY data
- Delete**          Delete current curve
- Add**             Add new curve to current plot

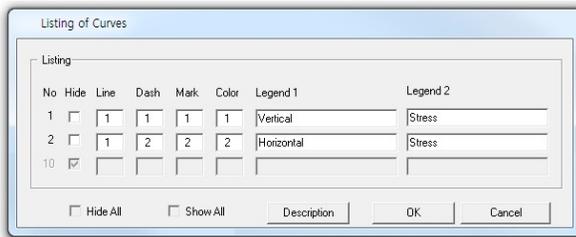


Figure 12.5a Listing of curves

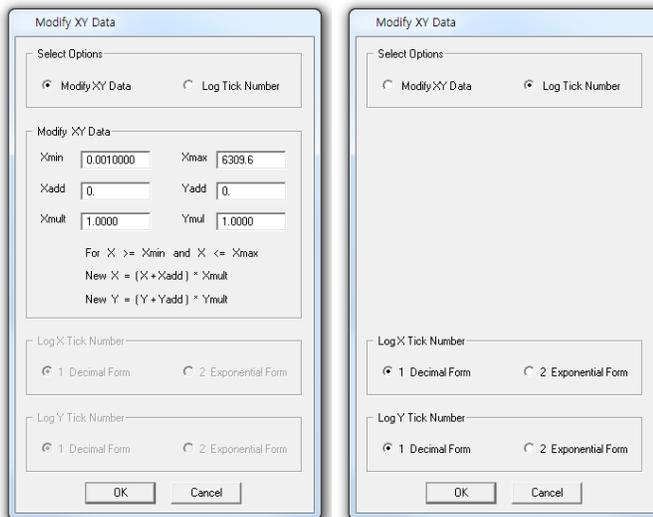


Figure 12.5b Modify current curve XY data

### **12.3.6 Command Buttons & Check Box**

Sample	Show Sample graph in Figure 12.3
Description	Show Curve options in Figure 12.4
Add as New Plot	Copy Current plot and Add as New plot
OK	Save and exit Edit dialog
Cancel	Cancel and exit Edit dialog

### **12.4 Existing Graph**

XY Graph can be opened by performing the following steps:

#### **Step 1:**

Select the following menu items in **SMAP**:

Plot → XY → PLOT XY → Open

#### **Step 2:**

If input file is **Draft Form**, then it will be automatically changed into **Standard Form** by **Converter DS** as listed in Table 12.3.

XY Graph will be displayed on **PLOT XY** drawing board.

#### **Step 3:**

XY Graph can be modified by **Edit Dialog** as explained in detail in the previous Section 12.3.

Refer to samples in the following directory:

C:\Smag\Smag3D\Example\XY\_Graph\PLOT XY Graph Sample.docx

## 12.5 Excel XY Graph

Excel XY Graph can be made by performing the following steps:

### Step 1:

Select the following menu items in **SMAP**:

Plot → XY → EXCEL → Open

### Step 2:

If input file is **Draft Form**, then it will be automatically changed into **Standard Form** by **Converter DS** as listed in Table 12.3.

Then this **Standard XY Graph** will be changed into **Excel Form** by **Converter SE** and displayed on **EXCEL Spreadsheet** as shown in Figure 12.6.

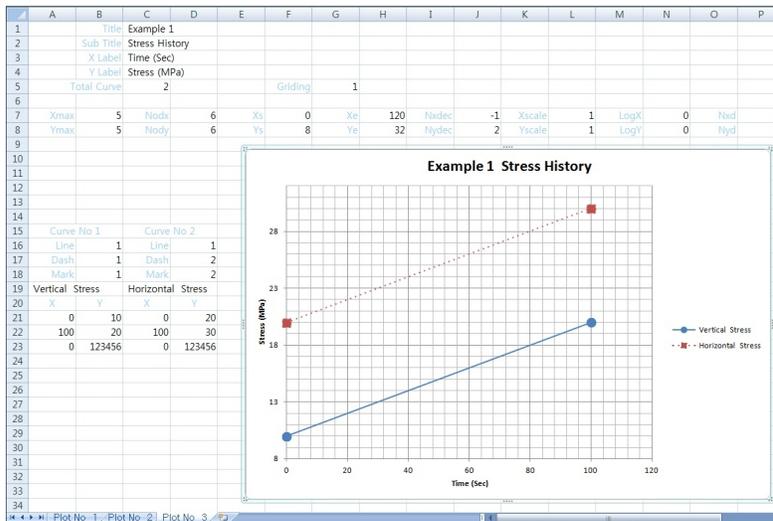


Figure 12.6 XY graph on Excel spread sheet

## Notes on Excel XY Graph

Excel XY Graph can be influenced by the following input parameters in [Standard Form](#):

### Note 1: Input Parameters Not Considered

Following parameters are not considered:

Plot dimensions: [XMAX](#) , [YMAX](#)

Number of digits after decimal point: [NXDEC](#), [NYDEC](#)

### Note 2: Automatic Scaling (Xscale = 0, Yscale = 0)

For [XSCALE = 0](#)

X axis is automatically scaled and [XS](#), [XE](#) and [NODX](#) are not used.

For [YSCALE = 0](#)

Y axis is automatically scaled and [YS](#), [YE](#) and [NODY](#) are not used.

### Note 3: Logarithmic Scaling (Logx = 1, Logy = 1)

For [LOGX = 1](#)

[NODX](#) and [NXD](#) are not used.

If [XSCALE](#)  $\neq$  0 and [XS](#) < 1 and [XE](#) > 1, [XS](#) is automatically scaled.

For [LOGY = 1](#)

[NODY](#) and [NYD](#) are not used.

If [YSCALE](#)  $\neq$  0 and [YS](#) < 1 and [YE](#) > 1, [YS](#) is automatically scaled.

Refer to samples in the following directory:

C:\Smap\Smap3D\Example\XY\_Graph\Excel XY Graph Sample.pdf

C:\Smap\Response\ModXY\EX2\Log Tick Number.pdf

## 12.6 SMAP Results

Figure 12.7 shows schematic flow diagram of processing **SMAP Results** corresponding to Card Group 12 in **SMAP Post File**.

This **Standard Form** of **PlotXy.dat** can be opened by either **PLOT XY** or **EXCEL** spreadsheet.

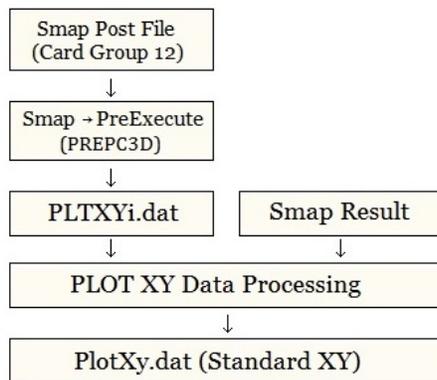


Figure 12.7 Processing SMAP results

**SMAP Results** can be plotted by performing following steps:

### Step 1:

Select the following menu items in **SMAP**:  
**Plot → Result**

### Step 2:

Select **PLOT XY** in **Plot Menu** dialog in Figure 12.8.

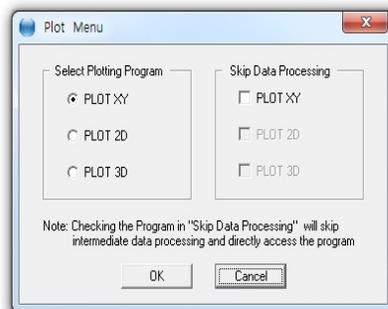


Figure 12.8  
Plot menu dialog

### 12.6.1 PLOT XY Setup

PLOT XY Setup in Figure 12.9 can be accessed by selecting the following item in SMAP main menu.

Setup → PLOT XY

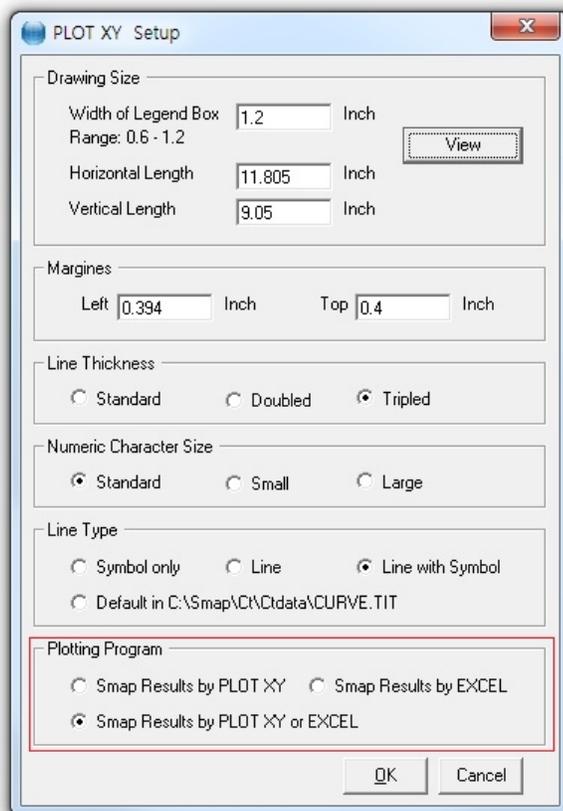


Figure 12.9 PLOT XY setup dialog

Refer to description in [Sample Graph](#) in Figure 12.4.

## 12.7 PlotXY Generator

**PlotXY Generator** is the graphical user interface which is mainly used to generate or edit **Simplified Time History** and **Simplified Snapshot** of Card Group 12 in **SMAP Post File**.

All different cases will be discussed in the following sections.

### 12.7.1 Accessing PlotXY Generator

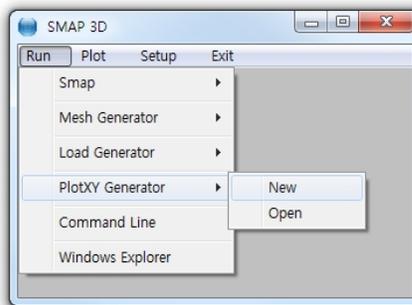
**PlotXY Generator** can be accessed by selecting the following item in **SMAP** main menu as in Figure 12.10.

Run → PlotXY Generator → New / Open

**New** is used to generate new Post File.

You can edit sample input with all different cases.

Figure 12.10  
Menu for PlotXY Generator



**Open** is used to edit existing Post File. You can specify different output Post File name as shown in Figure 12.11.

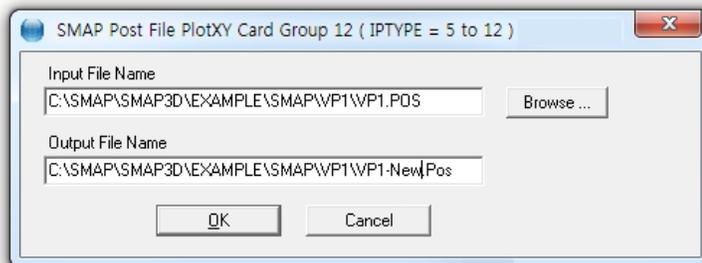


Figure 12.11 PlotXY input and output file dialog

### 12.7.2 Time History for a Given Element

Main Dialog for **Time History of Stresses / Strains for a Given Element** (IPTYPE = 5) is shown in Figure 12.12.

**Element** should be listed in Card 10.2.2 in **SMAP Main File**.  
**Table** shows available data as in Figure 12.13.

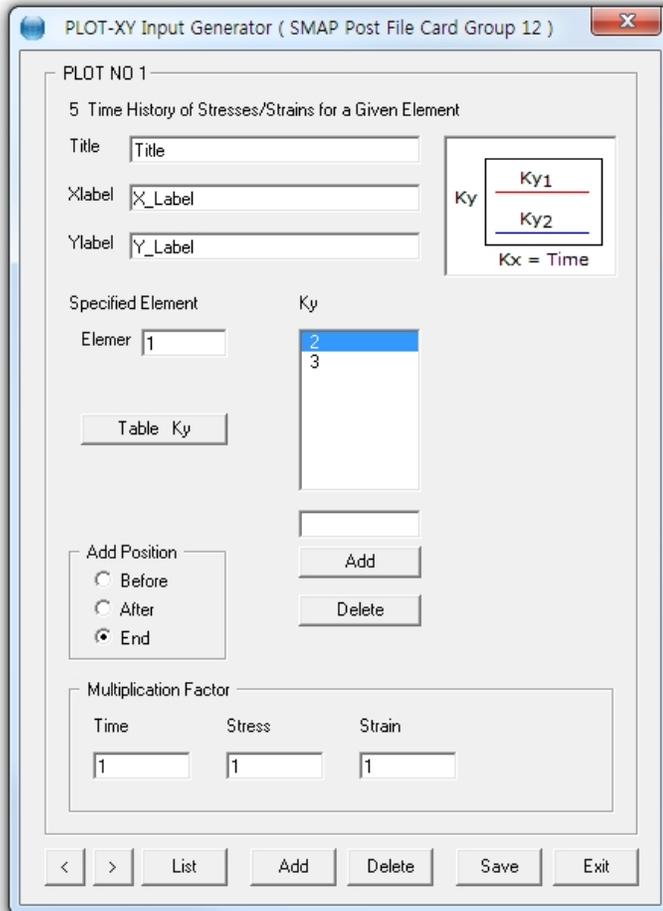


Figure 12.12 Time history for a given element

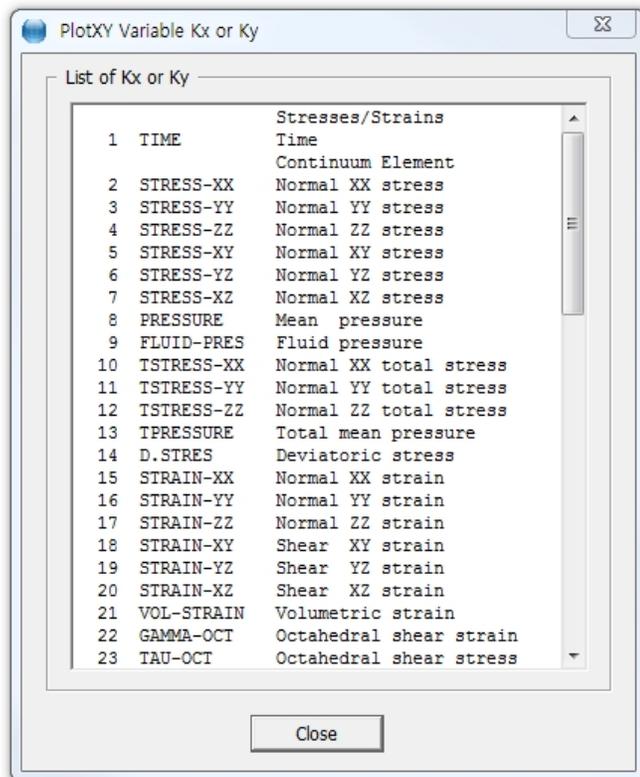


Figure 12.13 Available data for stresses / strains

### Buttons at Main Dialog Bottom

Back	Show previous plot
Next	Show next plot
List	Show listing of all plots
Add	Add new plot at the end
Delete	Delete the current plot
Save	Save all updates
Exit	Save and exit

List shows summary of all plots as shown in Figure 12.14.

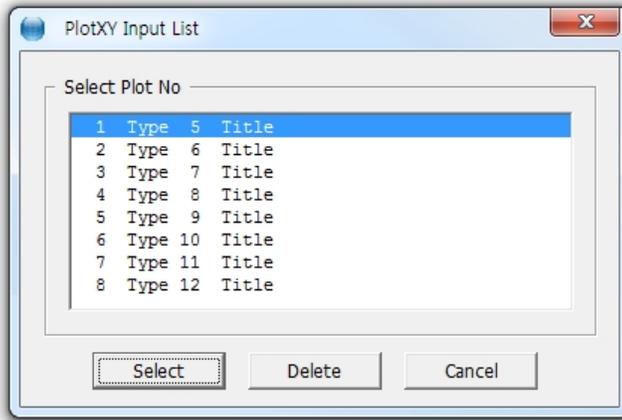


Figure 12.14 Listing of plots

Add shows new plot type to be added as in Figure 12.15.

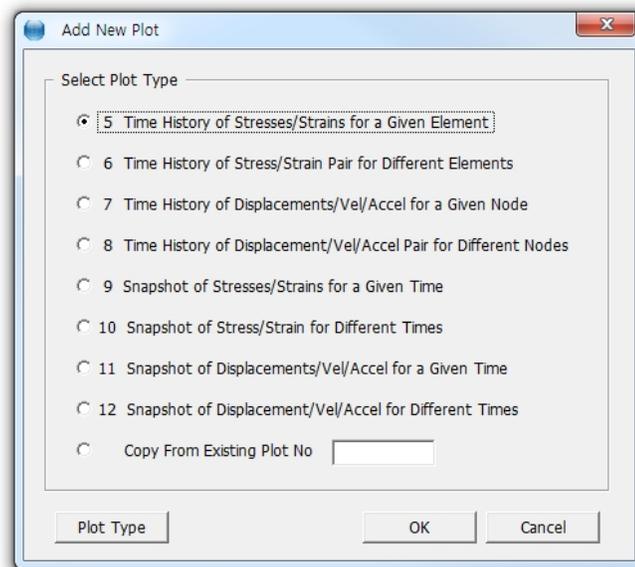


Figure 12.15 Add options for new plot

Plot Type in Add dialog illustrates graphically available plot types as shown schematically in Figure 12.16.

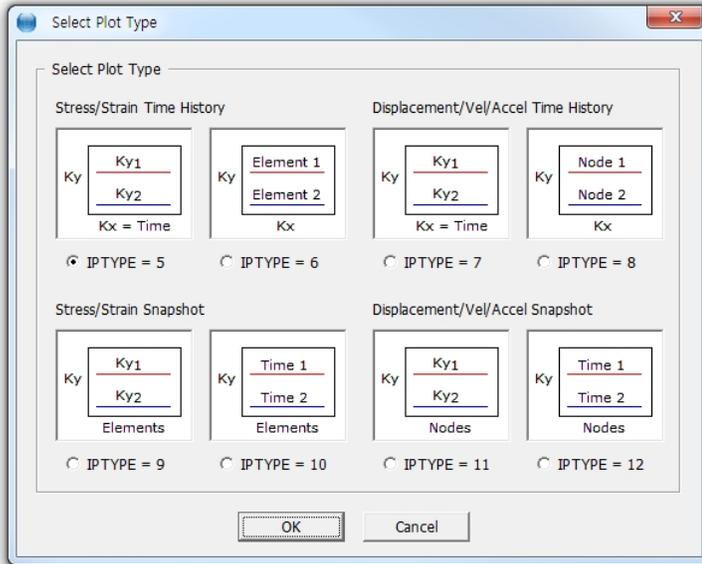


Figure 12.16 Available plot types

### 12.7.3 Time History for Different Elements

Main Dialog for [Time History of Stresses / Strains for Different Elements](#) (IPTYPE = 6) is shown in Figure 12.17.

[Elements](#) should be listed in Card 10.2.2 in [SMAP Main File](#). [Table](#) shows available data as in Figure 12.13.

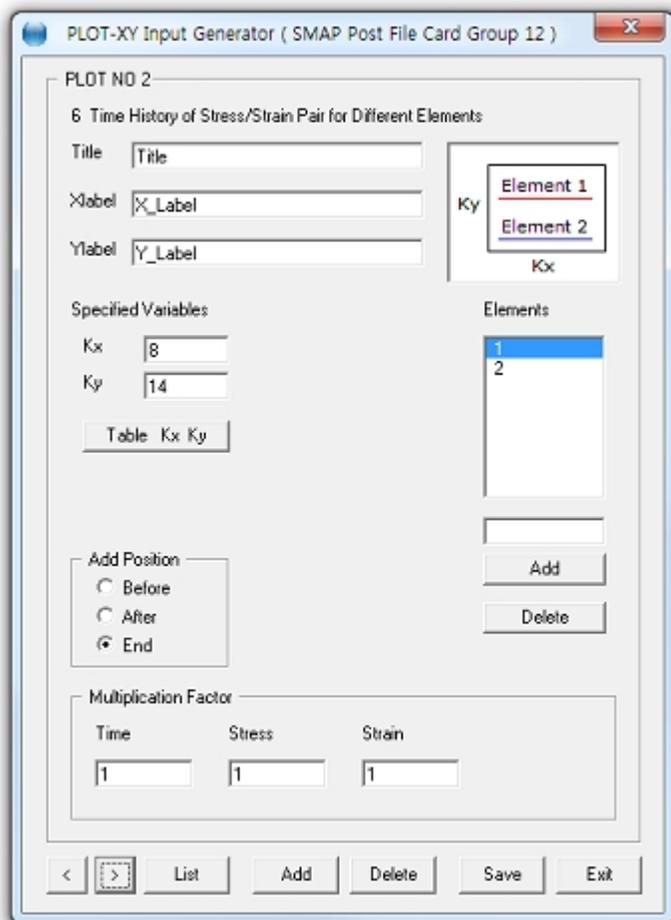


Figure 12.17 Time history for different elements

### 12.7.4 Time History for a Given Node

Main Dialog for **Time History of Displacement / Vel / Accel for a Given Node** (IPTYPE = 7) is shown in Figure 12.18.

**Node** should be listed in Card 10.3.2 in **SMAP Main File**. **Table** shows available data as shown in Figure 12.19.

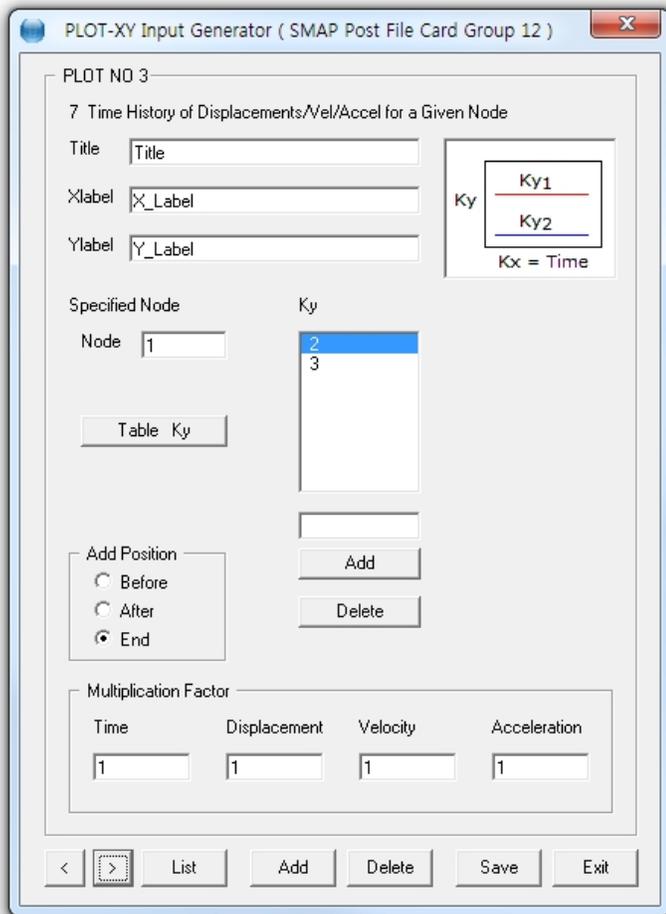


Figure 12.18 Time history for a given node

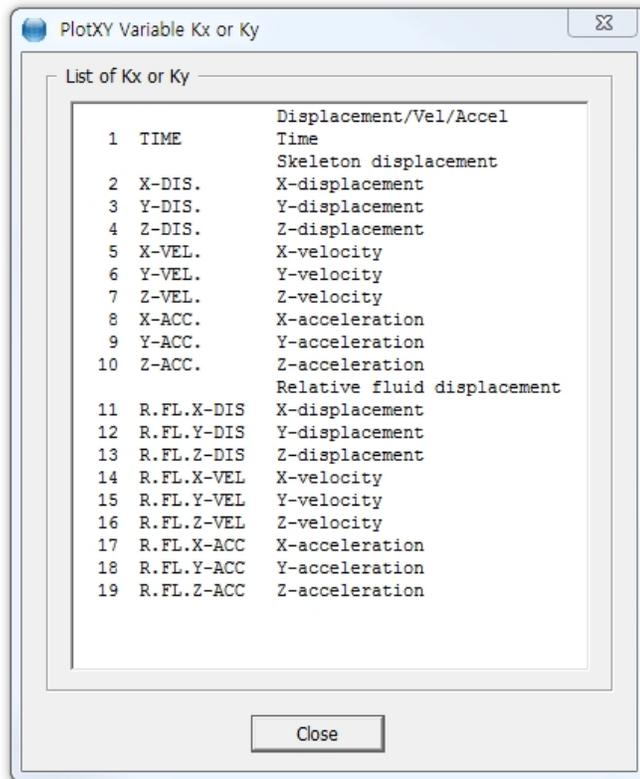


Figure 12.19 Available data for displacement/vel/accel

### 12.7.5 Time History for Different Nodes

Main Dialog for [Time History of Displacement / Vel / Accel for Different Nodes](#) (IPTYPE = 8) is shown in Figure 12.20.

[Nodes](#) should be listed in Card 10.3.2 in [SMAP Main File](#). [Table](#) shows available data as in Figure 12.19.

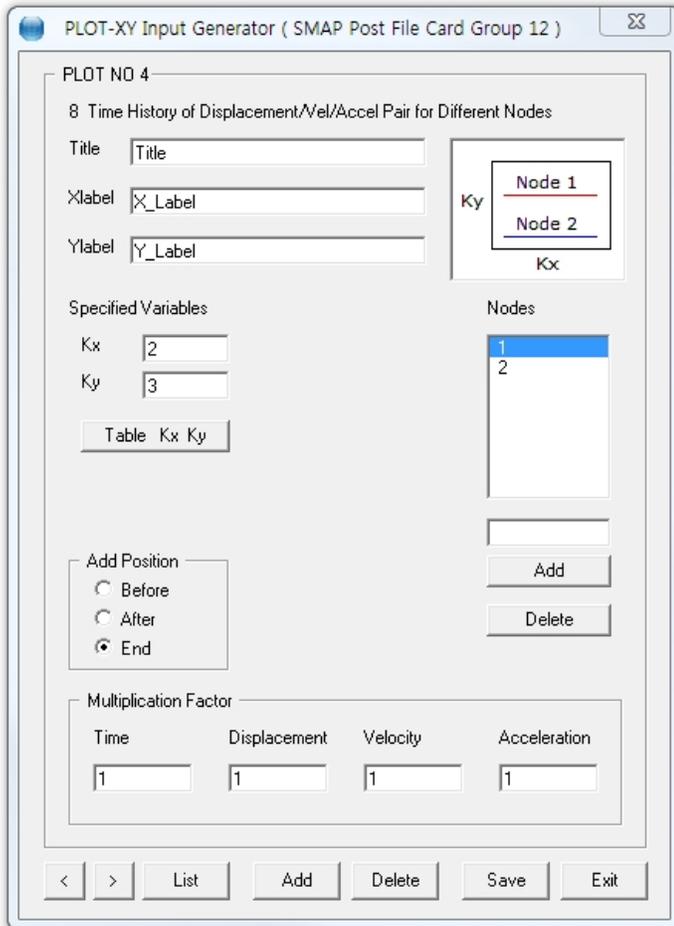


Figure 12.20 Time history for different nodes

### 12.7.6 Stress/Strain Snapshot for a Given Time

Main Dialog for [Snapshot of Stresses / Strains for a Given Time](#) (IPTYPE = 9) is shown in Figure 12.21.

[Time](#) should be listed in Card 10.4.2 in [SMAP Main File](#).

[Table](#) shows available data as in Figure 12.13.

[Elements](#) represent a series of data points in [SMAP Mesh](#).

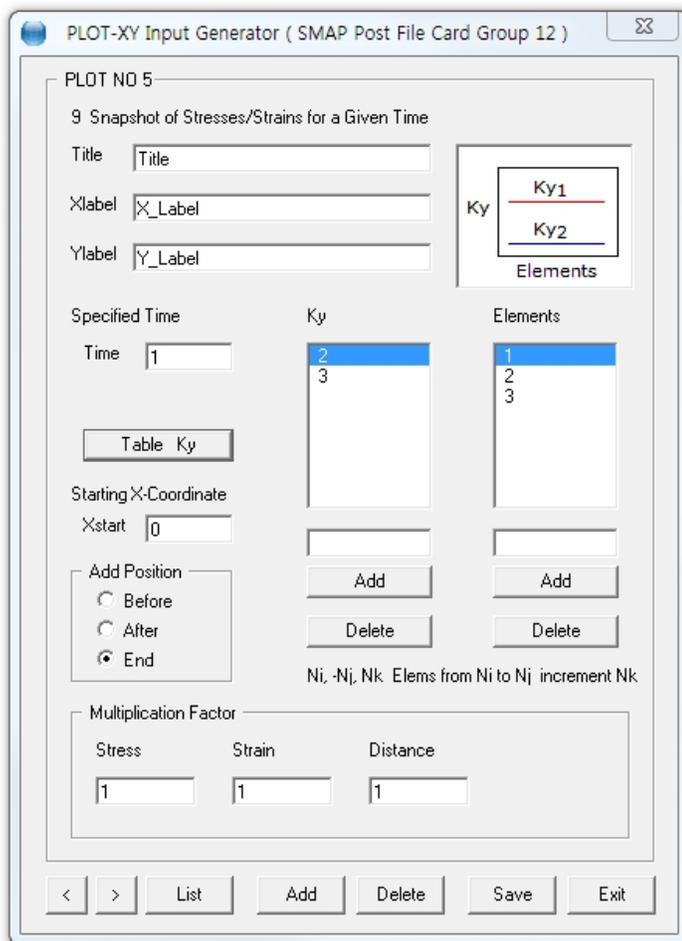


Figure 12.21 Stress/strain snapshot for a given time

### 12.7.7 Stress/Strain Snapshot for Different Times

Main Dialog for [Snapshot of Stresses / Strains for Different Times](#) (IPTYPE = 10) is shown in Figure 12.22.

[Times](#) should be listed in Card 10.4.2 in [SMAP Main File](#).

[Table](#) shows available data as in Figure 12.13.

[Elements](#) represent a series of data points in [SMAP Mesh](#).

This example will select a series of Elements (1,2,3,4,5,6,7,8,9,10).

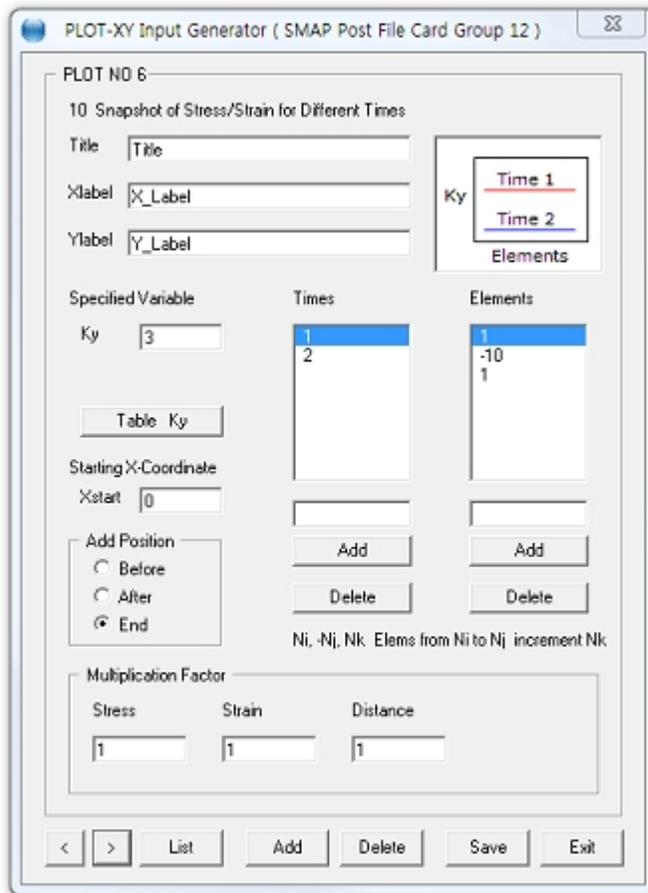


Figure 12.22 Stress/strain snapshot for different times

### 12.7.8 Displ/Vel/Acc Snapshot for a Given Time

Main Dialog for [Snapshot of Displacement / Vel / Accel for a Given Time](#) (IPTYPE = 11) is shown in Figure 12.23.

[Time](#) should be listed in Card 10.4.2 in [SMAP Main File](#).  
[Table](#) shows available data as in Figure 12.19.  
[Nodes](#) represent a series of data points in [SMAP Mesh](#).

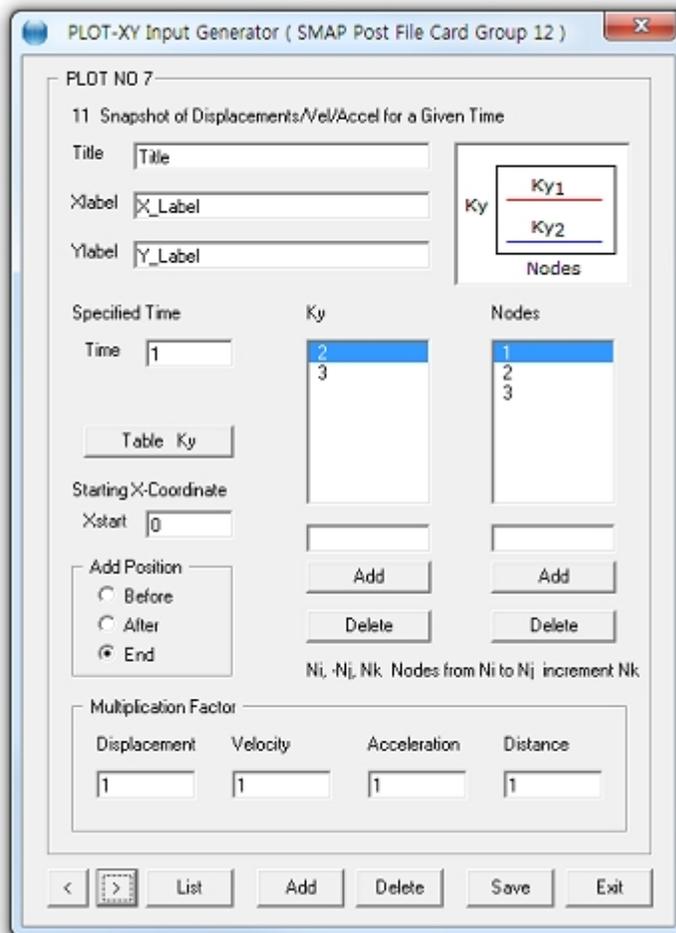


Figure 12.23 Displ/vel/accel snapshot for a given time

### 12.7.9 Displ/Vel/Acc Snapshot for Different Times

Main Dialog for [Snapshot of Displacement / Vel / Accel for Different Times](#) (IPTYPE = 12) is shown in Figure 12.24.

[Times](#) should be listed in Card 10.4.2 in [SMAP Main File](#).

[Table](#) shows available data as in Figure 12.19.

[Nodes](#) represent a series of data points in [SMAP Mesh](#).

This example will select a series of Nodes (1,2,3,11,13,15,17,19,21).

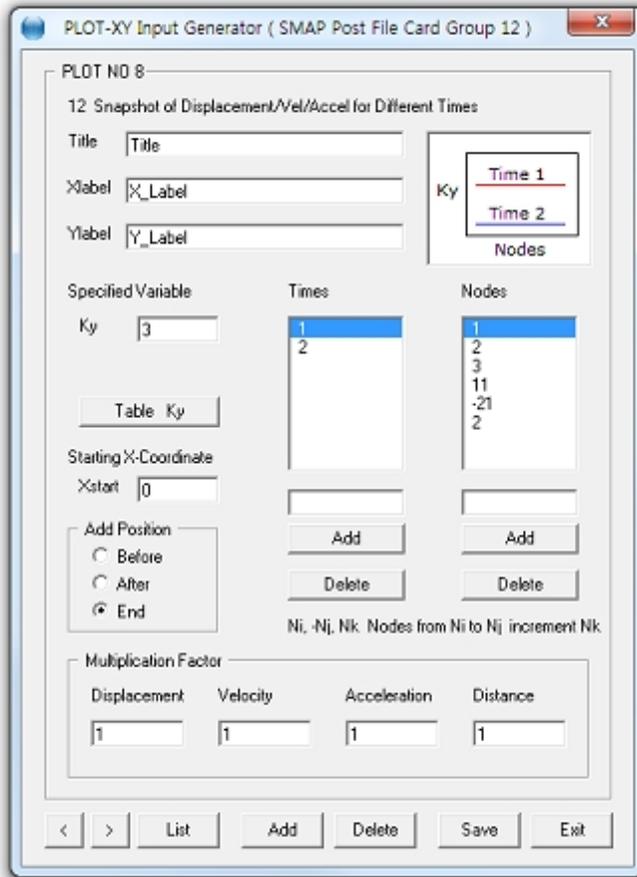


Figure 12.24 Displ/vel/accel snapshot for different times



# PLOT-XY

## User's Manual

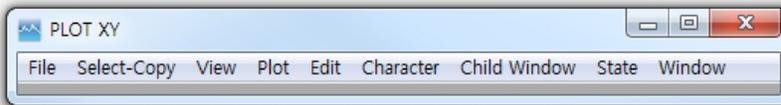
### 13.1 Introduction

PLOT-XY is a two-dimensional graphical program specially designed to perform scatter plotting and post processing for SMAP programs. The key features of PLOT-XY are:

- **Plot scatterplot data**  
It reads the scatterplot data in text file and plots lines connecting each pair of data points.
- **Plot results of analyses**  
It reads Card 12 of Post File and SMAP Output and plots time histories of stress/strain/displacement/temperature and snap shots of stress/strain/displacement/temperature vs. distance.
- **Edit XY graph**  
It reads XY data, edits titles and scales, adds user-defined additional curves.

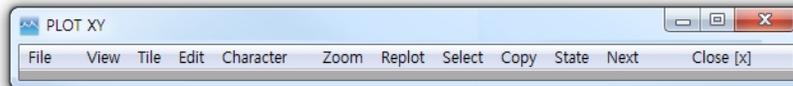
PLOT-XY has two menu styles, General and Express.

**General Style** includes 9 menus consisting of all menu items available. For General Style, specify 1 in C:\Smapi\Ct\Ctdata\MenuStyle\_XY.dat



**Express Style** includes 12 menus which are rearranged so as to quickly access most frequently used menu items in practice.

For Express Style, specify 0 in C:\Smapi\Ct\Ctdata\MenuStyle\_XY.dat



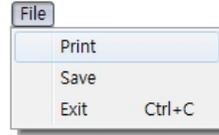
## 13.2 Menu

**File** has three sub menus.

**Print** is to get the hard copy of the current view.

**Save** is to save the current view.

**Exit** is to exit PLOT-XY.



**Select-Copy** is mainly used to select and then copy the current view.



**View** is mainly used to select

**Drawing View Size:**

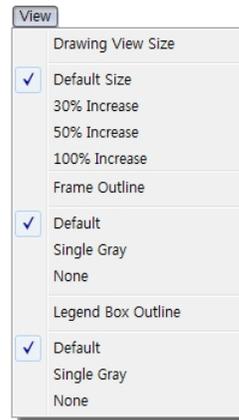
Default Size, 30%, 50%, or 100%

Increase **Frame Outline:**

Default, Single Gray, or None

**Legend Box Outline:**

Default, Single Gray, or None



**Plot** has the following five sub menus.

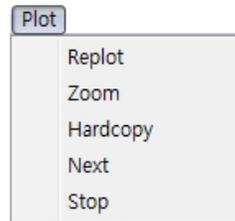
**Replot** is to replot the currently focused child window.

**Zoom** is to zoom the currently focused child window. Once this sub menu is selected, you can specify the rectangular zoom area by left mouse button down at the left top corner and then left mouse button up at the right bottom corner.

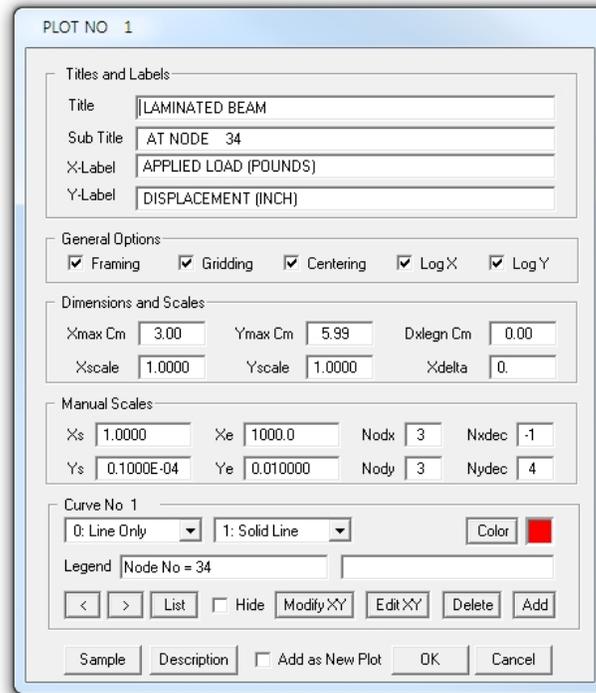
**Hardcopy** is to print the currently focused window.

**Next** is to plot the next graph.

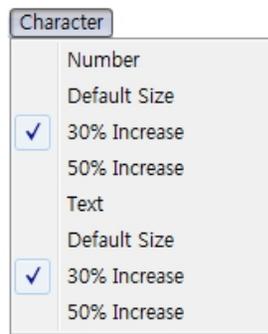
**Stop** is to stop plotting.



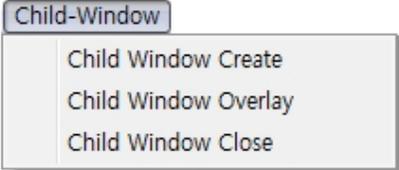
**Edit** opens following dialog to edit XY graph data.  
 It is described in detail in Section 12.3 in XY graph User's Manual.



**Character** is used to change sizes of number and text fonts. Default sizes are specified in PLOT-XY setup menu.



**Child-Window** is used to create, overlay, or close child window. A maximum of 40 child windows can be opened.



## PLOT-2D User's Manual

### 14.1 Introduction

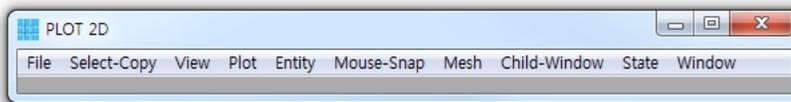
**PLOT-2D** is a two-dimensional graphical program specially designed to perform pre and post processing for SMAP programs.

The key features of PLOT-2D are:

- **Plot finite element meshes**  
It reads the Mesh File and plots meshes along with node, element, boundary code, and material numbers.
- **Plot results of analyses**  
It reads Mesh File, Card 11 of Post File, SMAP Output Files and plots contours of continuum stress/strain/temperature, beam section forces, truss axial force/stress/strain, principal stress vectors, and deformed shapes.
- **Edit finite element or group meshes**  
It reads finite element or group mesh files and edit these meshes.

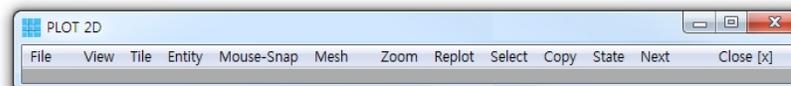
**PLOT-2D** has two menu styles, General and Express.

**General Style** includes 11 menus consisting of all menu items available. For General Style, specify 1 in `C:\Smap\Ct\Ctdata\MenuStyle_2D.dat`



**Express Style** includes 13 menus which are rearranged so as to quickly access most frequently used menu items in practice.

For Express Style, specify 0 in `C:\Smap\Ct\Ctdata\MenuStyle_2D.dat`

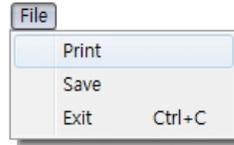


## 14.2 Menus

**File** has three sub menus.

**Print** is to get the hard copy of the current view.

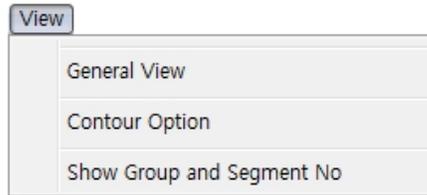
**Save** is to save the current mesh file. **Exit** is to exit PLOT-2D.



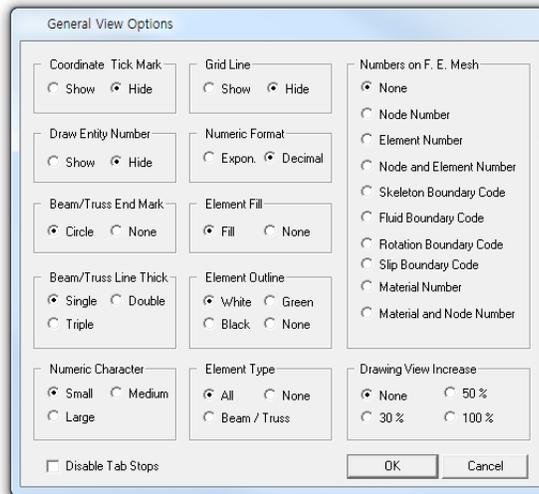
**Select-Copy** is mainly used to select and then copy the current view.



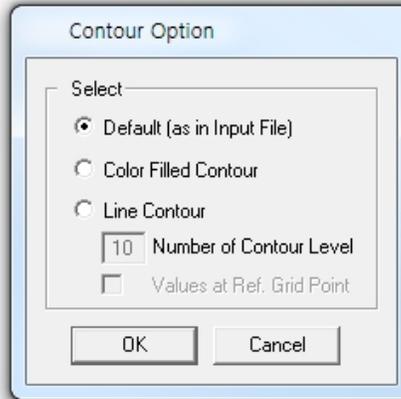
**View** has three sub menus; General View, Contour Option, and Show Group and Segment No.



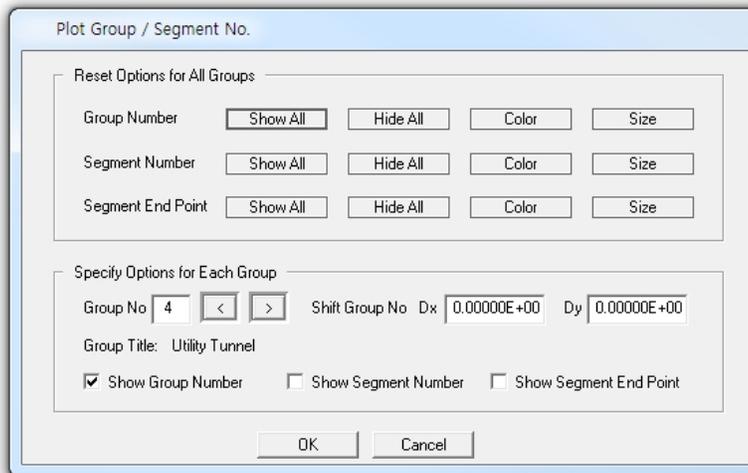
**General View** options affect all types of plots.



**Contour Options** affect contour plots of continuum element data for analysis results.



**Show Group and Segment No** is to show group and segment numbers when editing group meshes. It is described in detail in Section 5.3 in Group Mesh User's Manual.



**Plot** has the following five sub menus.

**Replot** is to replot the currently focused child window. **Zoom** is to zoom the currently focused child window.

It zooms only mesh. Once this sub menu is selected, you can specify the rectangular zoom area by left mouse button down at the left top corner and then left mouse button up at the right bottom corner.

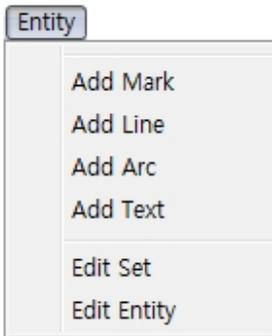
**Hardcopy** is to print the currently focused window.

**Next** is to plot the next graph.

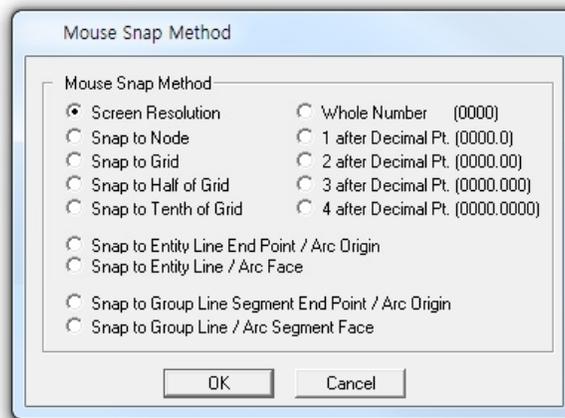
**Stop** is to stop plotting.



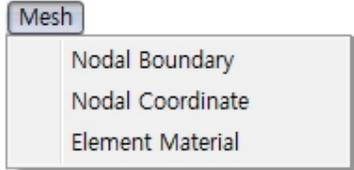
**Entity** is the graphical object which is mainly used to assist editing geometry of groups and elements. It has following six sub menus; Add Mark, Add Line, Add Arc, Add Text, Edit Set, and Edit Entity. It is described in detail in Section 5.7 in Group Mesh User's Manual.



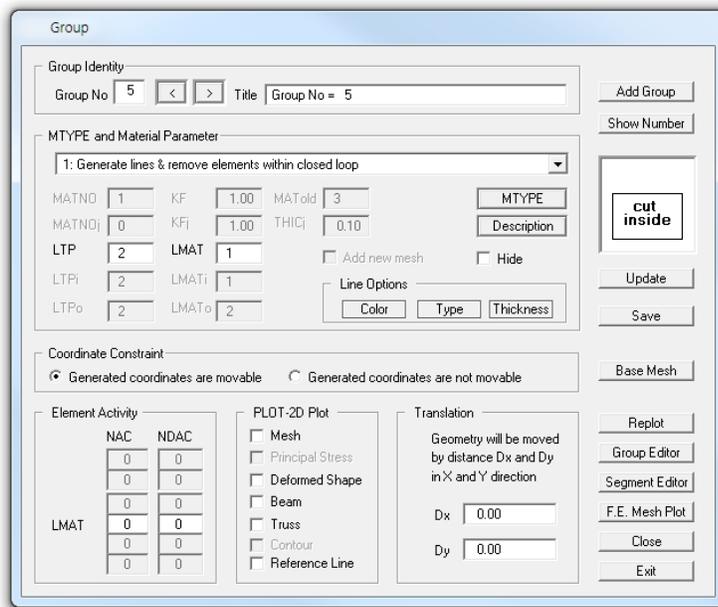
**Mouse-Snap** is to control the position of mouse cursor when you work for finite element mesh, group mesh, or entities. Mouse Snap Method helps you place the mouse cursor more accurately.



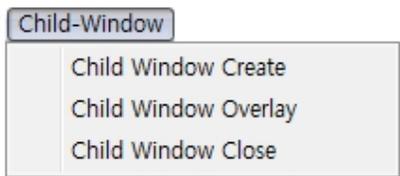
**Mesh** is used to directly modify finite element meshes. It has three sub menus; Nodal Boundary, Nodal Coordinate, and Element Material. It is described in detail in Section 5.6 in Group Mesh User's Manual.



**Group** is used to build or edit group mesh. It is described in detail in Section 5.3 in Group Mesh User's Manual.



**Child-Window** is used to create, overlay, or close child window. A maximum of 40 child windows can be opened.





## PLOT-3D User's Manual

### 15.1 Introduction

**PLOT-3D** is a three-dimensional graphical program specially designed to perform pre and post processing for SMAP programs. The key features of PLOT-3D are:

- **Plot finite element meshes**  
It reads the Mesh File and plots meshes along with node, element, boundary code, and material numbers.
- **Plot results of analyses automatically**  
It reads Mesh File and SMAP Output Files and with no input for Post File, plots contours of stress/strain/displacement, iso surface, principal stress vectors, load vectors, temperatures, total heads and deformed shapes.
- **Compute intersections of surfaces**  
It reads the Mesh File containing shell elements for 3D surfaces and shows the locations of the computed intersections. The computed coordinates of intersections are saved in a file "Intersection.dat" which can be used for the construction of complicated 3D meshes.

**PLOT-3D** has 5 menus; File, Model, Plot, View and Help along with 25 toolbars.



## 15.2 Menus

**File** has six sub menus.

**New** is used to build Finite Element Mesh or Block Mesh.

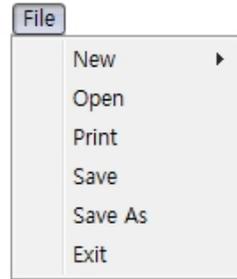
**Open** is used to open existing mesh file.

**Print** is to get the hard copy of the current view.

**Save** is to save the current mesh file or current view.

**Save As** is to save the current mesh file as another name.

**Exit** is to exit PLOT-3D.



**Model** is mainly used to edit Finite Element or Block Mesh file.

For detailed description, refer to Block Mesh User's Manual in Section 6.

For editing Finite Element Mesh, 6 menus are shown.

**New** is to build new mesh file.

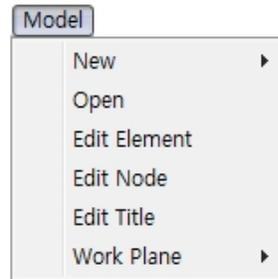
**Open** is to open existing mesh file.

**Edit Element** is to edit parameters related to element.

**Edit Node** is to edit parameters related to node.

**Edit Title** is to edit title.

**Work Plane** is to show prebuilt work planes.



For editing Block Mesh, 6 menus are shown.

6 menus are shown.

**New** is to build new mesh file.

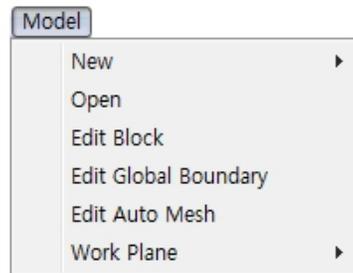
**Open** is to open existing mesh file.

**Edit Block** is to edit parameters related to block.

**Edit Global Boundary** is to edit parameters related to boundary.

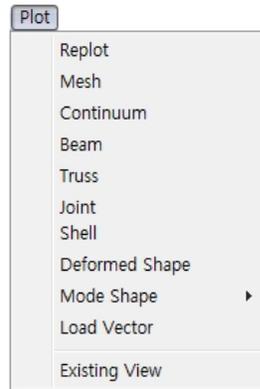
**Edit Auto Mesh** is to edit parameters related to auto mesh.

**Work Plane** is to show prebuilt work planes.



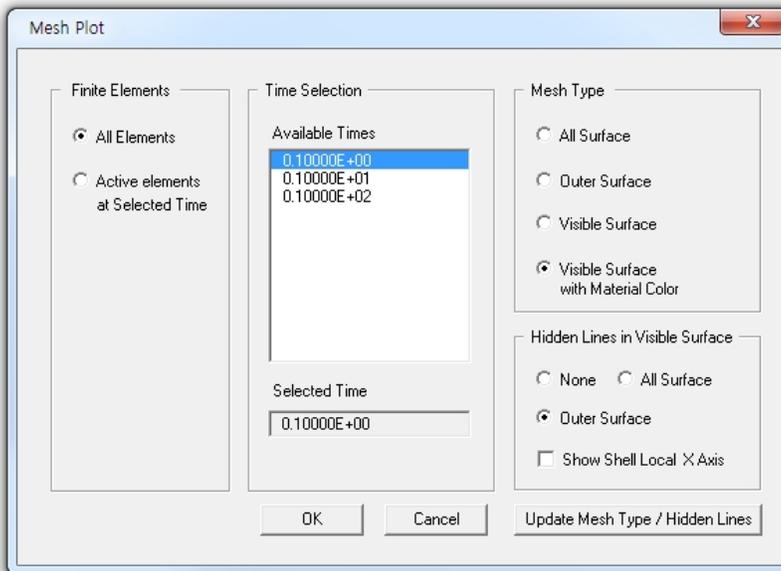
**Plot** is mainly used to plot Finite Element mesh and analysis results.

It has 11 sub menus; Replot, Mesh, Continuum, Beam, Truss, Joint, Shell, Deformed Shape, Mode Shape, Load Vector, Existing View. Joint plot is not available.

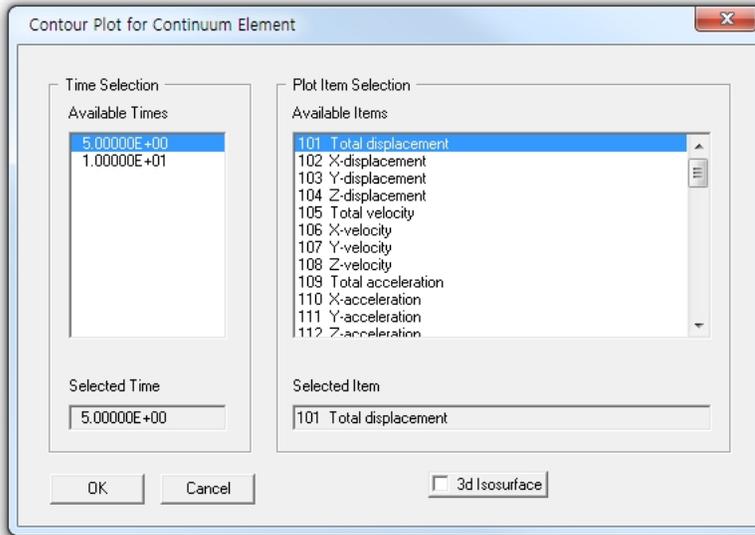


**Replot** is mainly used to refresh the current view.

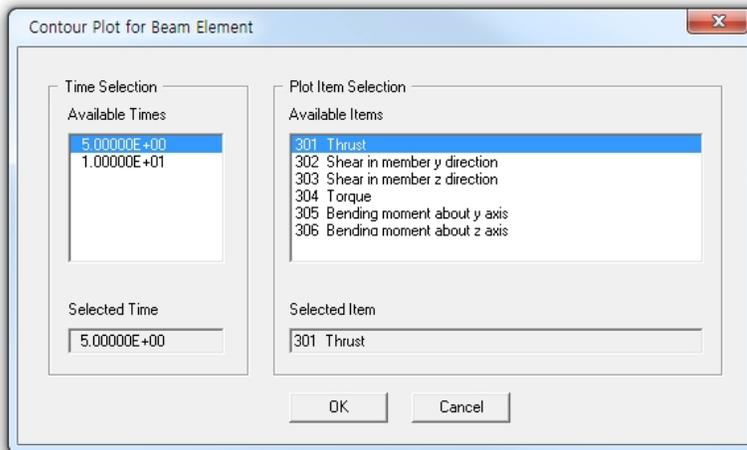
**Mesh** is to plot Finite Element meshes (Default plot type). Mesh plot requires only Mesh File.



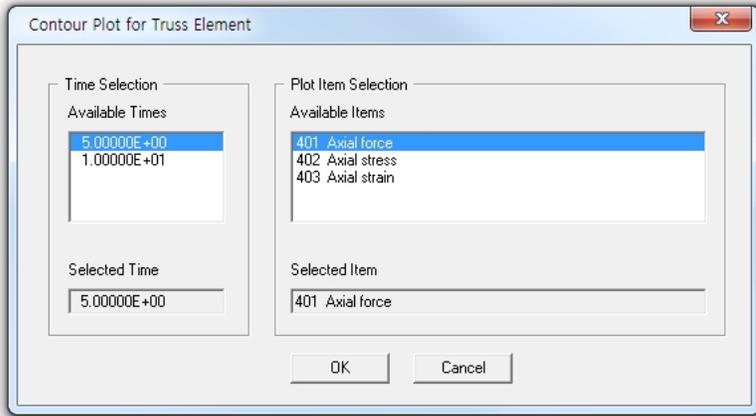
**Continuum** is to plot contours or principal stress vectors for continuum elements. By checking "3d Isosurface", iso surface will be shown.



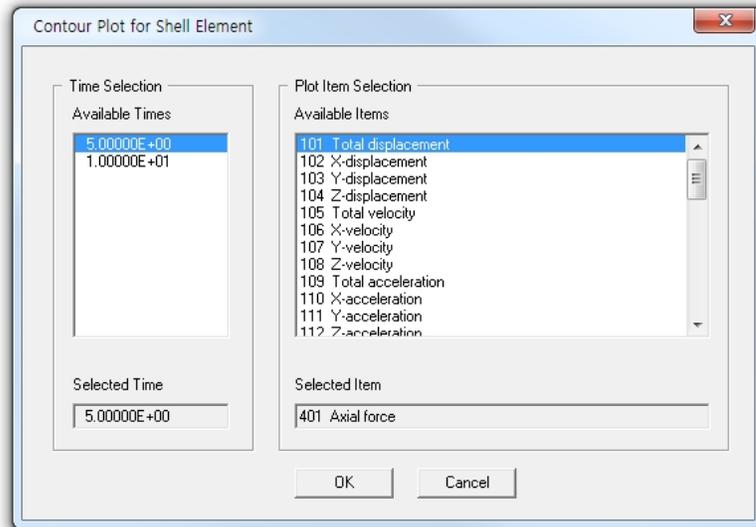
**Beam** is to plot section forces of beam elements.



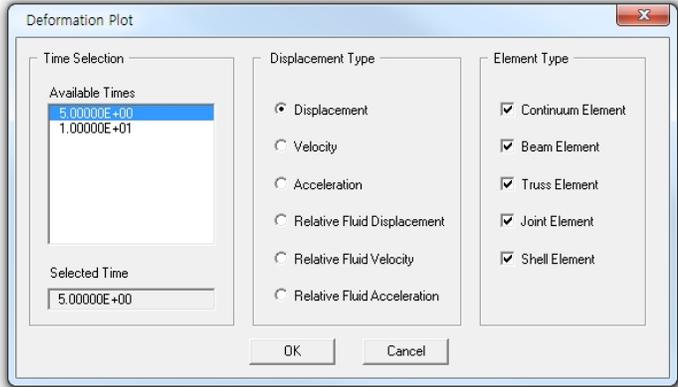
Truss is to plot axial force/stress/strain of truss elements.



Shell is to plot contours or principal stress vectors for shell elements.

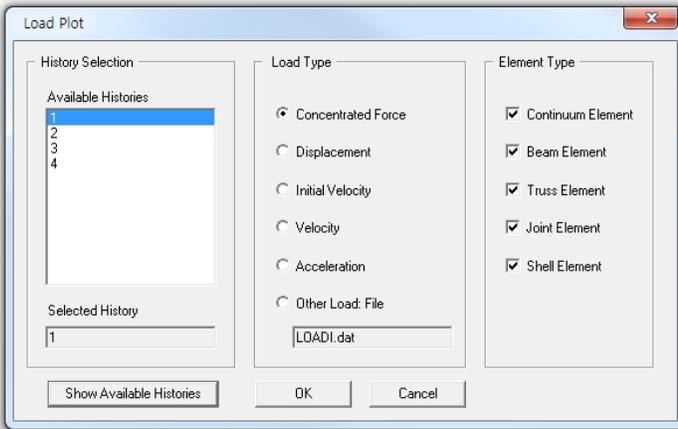


**Deformed Shape** is to plot the snap shot of all kinds of displacement/velocity/accelerations. Note that deformed meshes can be combined with other plot types as discussed in "Displacement" option in view menu.

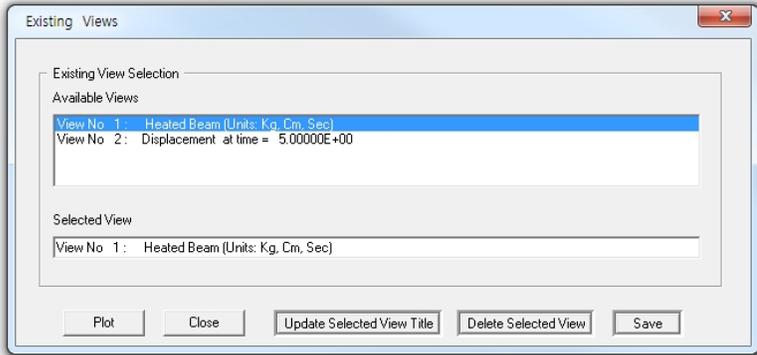


**Mode shape** is to plot mode shapes of modal analyses for SMAP-2D/3D

**Load Vector** is to plot the external loads of concentrated forces/displacements/velocities/accelerations along with load intensity. Note that load vectors can be plotted on deformed meshes as discussed in "Load Vector" option in view menu.

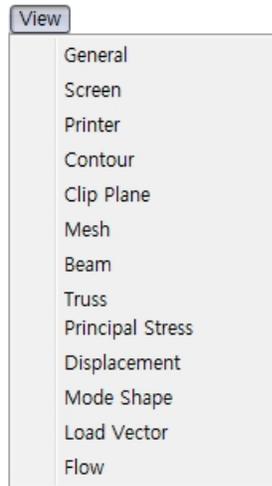


**Existing View** is to replot the saved views.



**View** is used to change the appearance of a selected plot.

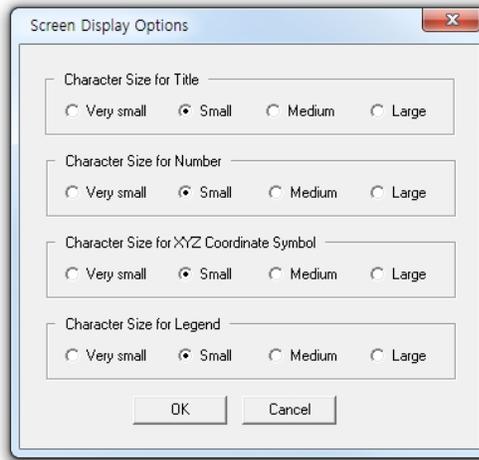
It has thirteen sub menus; General, Screen, Printer, Contour, Clip Plane, Mesh, Beam, Truss, Principal Stress, Displacement, Mode Shape, Load Vector and Flow.



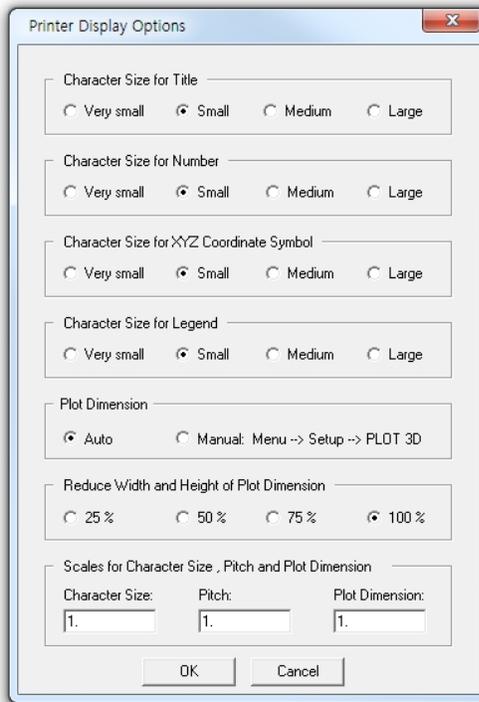
General view options affect most plot types.



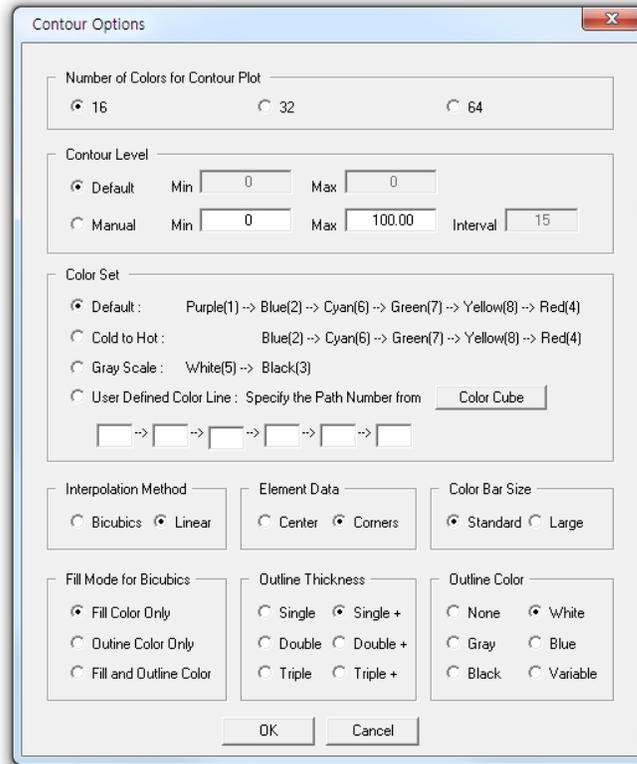
Screen display options affect character sizes shown on the monitor.



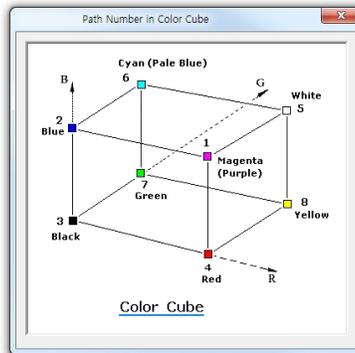
Printer display options affect character sizes and plot dimensions shown on the hard copy.



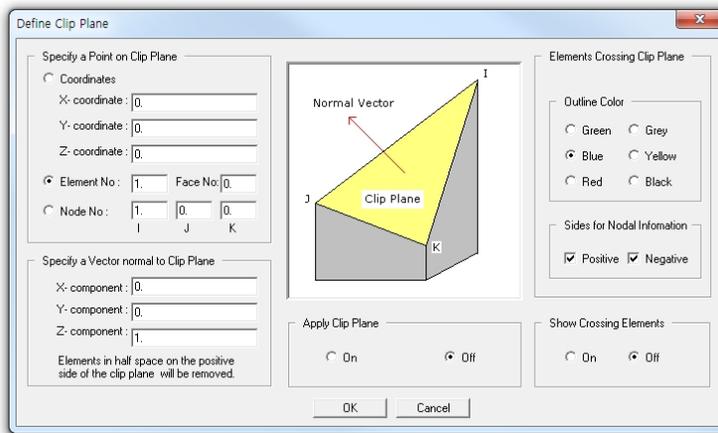
Contour options affect all types of plots involving contours.



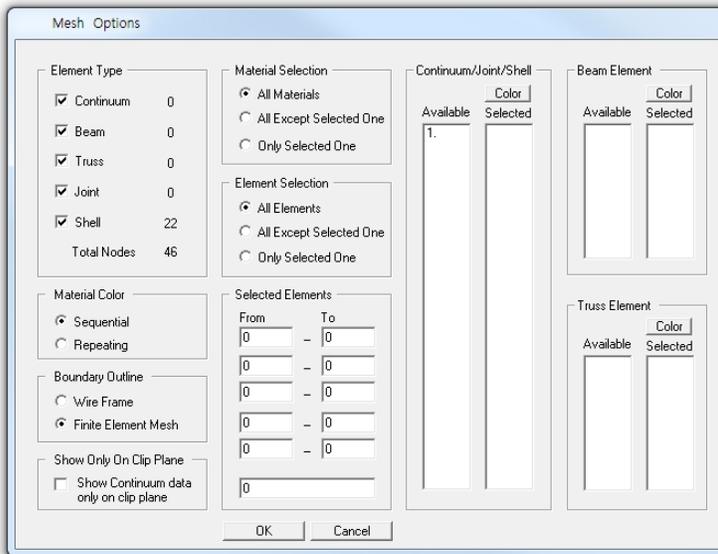
Color cube is to use for user defined color line.



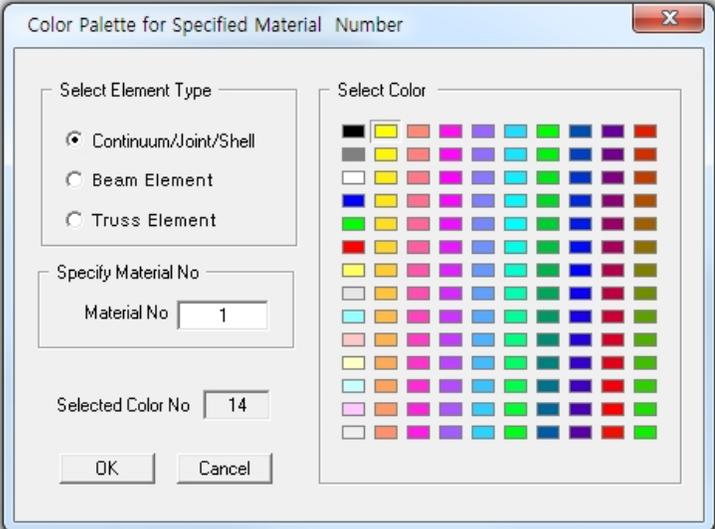
**Clip plane** defines parameters associated with the clip plane which cuts through the internal part of the 3D domain. When "Apply Clip Plane" is on, contours or deformed shapes are shown on such user defined plane.



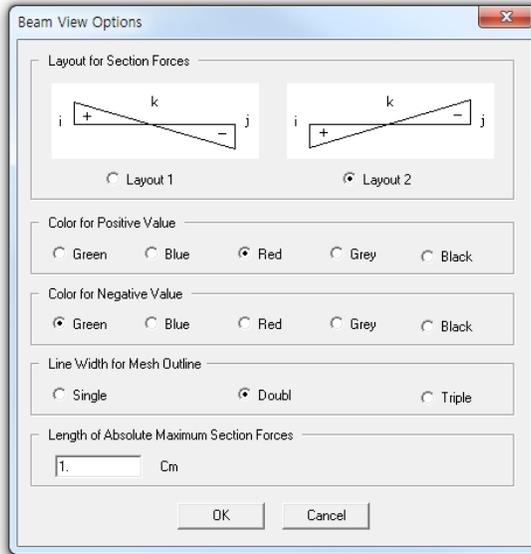
**Mesh** options affect all plot types. As one of useful features, it can select particular types of elements and materials.



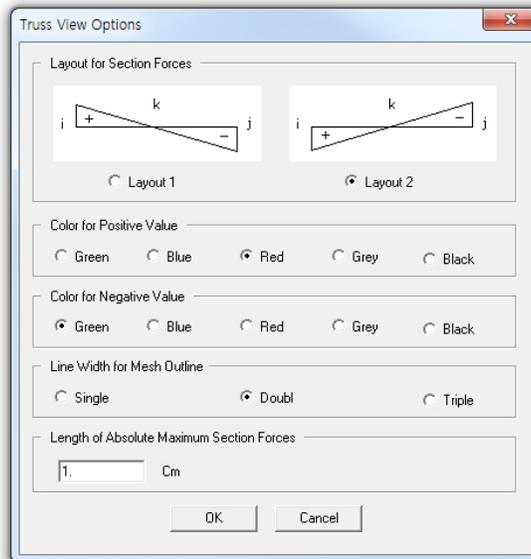
Color is to use for user defined mesh color.



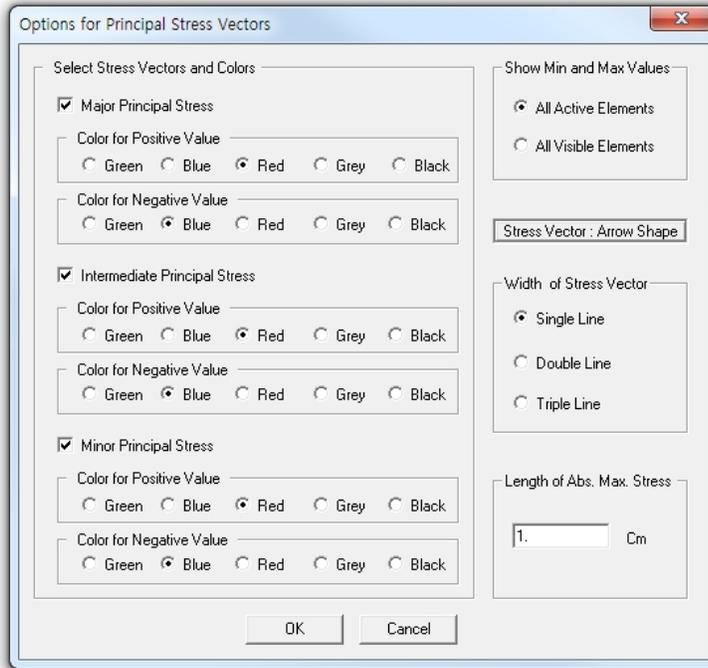
Beam view options affect only beam plot.



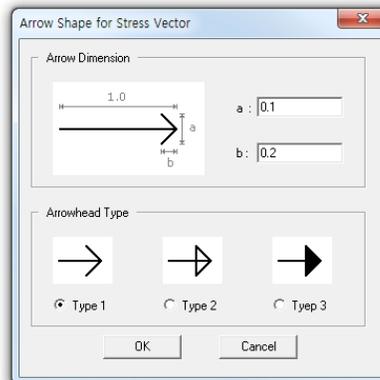
Truss view options affect only truss plot.



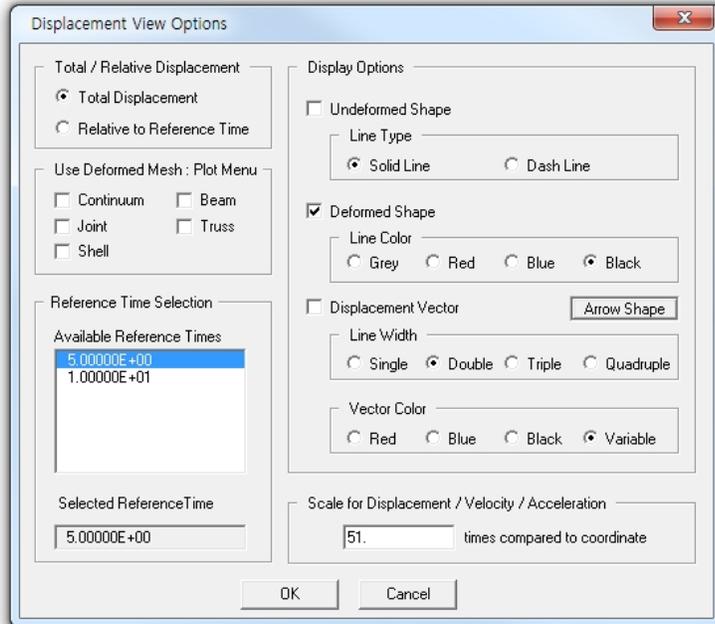
Principal Stress options affect only plots of principal stress vectors in continuum or shell elements.



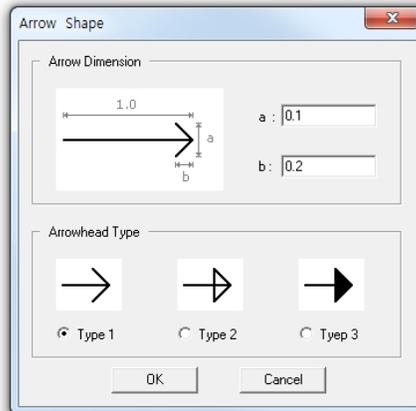
Users can specify the arrow shape for stress vector.



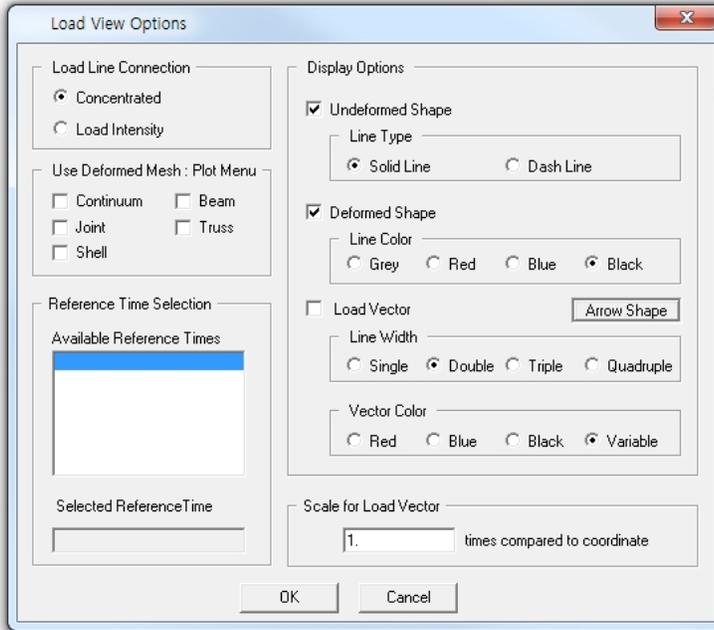
Displacement view options affect only deformed shape plot. Continuum, Beam, Truss, and Shell plots can be displayed over deformed mesh by checking types in "Use Deformed Mesh".



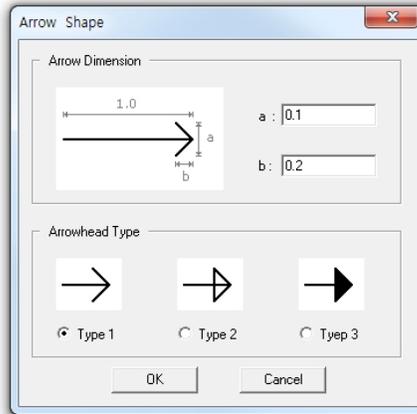
Users can specify the arrow shape for displacement vector.



Load Vector view options affect only load vector plot. Load vectors can be displayed over deformed mesh by checking "Deformed Shape" in Display Options

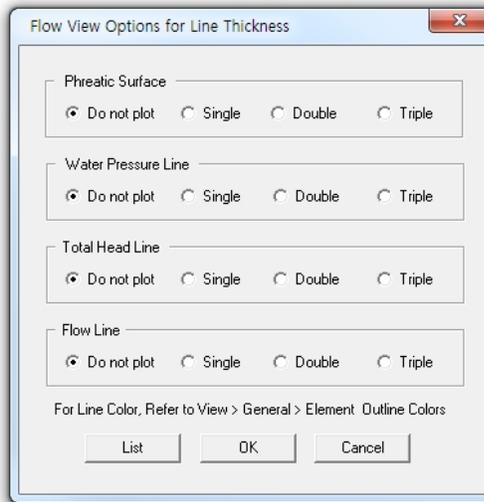


Users can specify the arrow shape for load vector.



Flow view options affect only SMAP-W2 and SMAP-W3 plots. You can control visibility and line thickness of

- Phreatic surface
- Water pressure line
- Total head line
- Flow line



Line colors of flow data can be selected in General view options.



## 15.3 Toolbars

### Open Toolbar

This button activates the file open dialog box to open mesh file.



### Print Toolbar

This button is used to get the hard copy of current view.



### Save Toolbar

This button is used to save current view or working file.



### Model Toolbar

This button is used to edit finite element or block mesh.



### Work Plane Toolbar

This button is to set work plane used for Model.



### Layout Toolbar

These buttons are used to show different layouts.

The first button divides the plot area into three parts; mesh, title, and legend. The second button divides the plot area into two parts; mesh and title.



### XYZ Toolbar

This button is used to locate position of XYZ coordinate symbol in the two part layout mode. Each time you click this button, the XYZ symbol moves counterclockwise along the corners of rectangle. XYZ button is also used to control the amount of movement, rotation, and zoom.



**Zoom Toolbar**

The first button is used to magnify the mesh.



And the second button is used to reduce the mesh.

The third button is used to activate the selection of zoom area.

Once this button is on, you can specify the rectangular zoom area by left mouse button down at the left top corner and left mouse button up at the right bottom corner. To deactivate, click the button again.

The fourth button is used to switch from the currently zoomed view to the previously zoomed view or vice versa. The last button with "A" is to go back to the initial default configuration.

**Translation Toolbar**

The first button is to activate drag mode. Once this button is on, you can move the mesh by dragging the mouse. To deactivate, click the button again.



The other buttons move the mesh to the left, right, up, and down, respectively.

**Rotation Toolbar**

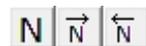
The first button changes direction of rotation.



The other three buttons rotate the mesh about X, Y, and Z axes, respectively.

**Number Toolbar**

The first button is to activate number mode.



Once this button is on, the selected data will be shown.

Clicking the button again will hide the selected data.

The other two buttons are used to select next and previous number, respectively. The description of selected number is listed at the bottom of PLOT-3D window.



## 16. SWCC

SWCC program supports following three SWCC models:

- van Genuchten (1980)
- Fredlund and Xing (1994)
- Brutsaert (1966) and Gardner (1958)

Graphical output file:

### **SWCC.Lin**

Provides following seven plots as a function of soil suction:

- Volumetric water content
- Normalized volumetric water content
- Specific moisture capacity
- Relative hydraulic conductivity
- Absolute hydraulic conductivity in log scale
- Absolute hydraulic conductivity in arithmetic scale
- Volumetric water content vs absolute hydraulic conductivity

Text output files:

### **PresfunctionM.dat**

Generates following data as a function of soil suction:

- Permeability and specific moisture capacity

### **PresfunctionV.dat**

Generates following data as a function of soil suction:

- Permeability and volumetric water content

### **PresfunctionA.dat**

Generates following data as a function of soil suction head:

- Permeability, volumetric water content and water capacity

Note:

Graphical file SWCC.Lin can be plotted by PLOT-XY.

Text output files can be used as input data for SMAP-F2/W2/W3.

Input Data and Definitions (Main File)	
SWCC Input Data	<p>1.0</p> <p>TITLE</p> <p>TITLE            Title (Max 50 characters)</p>
	<p>2.0</p> <p>MATFN, MW, GW, KSAT, XSmin, XEmax, DLX</p> <p>MATFN = 11    van Genuchten (1980)</p> <p>          = 12    Fredlund and Xing (1994)</p> <p>          = 13    Brutsaert (1966) and Gardner (1958)</p> <p>MW            Specific moisture capacity at saturation</p> <p>GW            Unit weight of water</p> <p>KSAT          Saturated permeability</p> <p>XSmin        Min suction (Default XSmin = 1.0e-3)</p> <p>XEmax        Max suction (Default XEmax = 1.0e+6)</p> <p>DLX          Increment of suction in common log scale (Default DLX = 0.02, Min increment = 0.001)</p>

Input Data and Definitions (Main File)	
SWCC Input Data	3.
	<b>For MATFN = 11 or 12</b>
	VWCsat, VWCres, a, n, m, Uswcc, SCFac, Gwm, Pr
	VWCsat Saturated volumetric water content
	VWCres Residual volumetric water content Not used for MATFN = 12
	a, n, m Parameters defining unsaturated hydraulic conductivity and water storage. <b>For MATFN = 11</b> , default $m = 1 - 1/n$ For $n = m = 0$ , Simple Gardner (1958) is used.
	Uswcc Unit in fitting SWCC model 0: pressure unit, 1: pressure head unit
	SCFac Conversion factor from user input unit to SWCC model unit in terms of length
	Gwm Unit weight of water in SWCC model used for Uswcc = 0
	Pr Suction at VWCres. Used for MATFN = 12 <b>When Pr &gt; 0</b> , assumes that suction in SWCC model is expressed in terms of kPa
	<b>For MATFN = 13</b>
	VWCsat, VWCres, A <sub>1</sub> , n <sub>1</sub> , A <sub>2</sub> , n <sub>2</sub> , SCFac
	A <sub>1</sub> , n <sub>1</sub> Parameters defining unsaturated hydraulic conductivity, Brutsaert (1966)
A <sub>2</sub> , n <sub>2</sub> Parameters defining unsaturated water storage, Gardner (1958)	
SCFac Conversion factor from user input unit to SWCC model unit in terms of length	



# SMAP<sup>®</sup> - W3

Structure Medium Analysis Program

3-D Seepage Analysis

Example Problems



**Contents**

<b>1. Introduction</b> . . . . .	1-1
<b>2. Pre-Processing Programs</b> . . . . .	2-1
<b>3. Main- and Post-Processing Programs</b> . . . . .	3-1
<b>4. SMAP-W3 Example Problems</b>	
4.1 1-D Transient Linear Consolidation. . . . .	4-2
4.2 1-D Transient Infiltration. . . . .	4-13
4.3 Square Dam Under Rapid Drawdown. . . . .	4-24
4.4 Steady-State Radial Flow Toward Well . . . . .	4-37
4.5 Transient Seepage Through Generic Levee . . . . .	4-48
4.6 Steady-State Seepage Through Earth Dam . . . . .	4-60
<b>5. Group Mesh Example</b>	
5.1 Arch Tunnel . . . . .	5-2
5.1.1 Part 1: Creating Arch Tunnel. . . . .	5-5
5.1.2 Part 2: Adding Rock Bolts . . . . .	5-15
5.1.3 Part 3: Adding Utility Tunnel . . . . .	5-20
5.2 Finite Element Mesh Modification	
5.2.1 Overview . . . . .	5-27
5.2.2 Change Top Surface Nodal Coordinates. . . . .	5-29
5.2.3 Change Top Surface Nodal Boundaries. . . . .	5-33
5.2.4 Change Top Layer Element Materials . . . . .	5-36
<b>6. Block Mesh Example</b>	
6.1 Single Element. . . . .	6-2
6.2 Cube Earth Dam. . . . .	6-19
6.2.1 Part 1: Creating Cube Earth Dam. . . . .	6-21
6.2.2 Part 2: Modifying Cube Earth Dam . . . . .	6-30
<b>7. PRESMAP Example</b>	
7.1 PRESMAP-2D. . . . .	7-1
7.1.1 Model 1 . . . . .	7-2
7.1.1.1 Core Region Mesh Generation. . . . .	7-6
7.1.1.2 Far-Field Region Mesh Generation. . . . .	7-13
7.1.2 Model 2 . . . . .	7-20
7.1.3 Model 3 . . . . .	7-28
7.1.4 Model 4 . . . . .	7-33

7.2	NATM-2D. . . . .	7-36
7.2.1	Model 1 Single Tunnel (Half Section). . . . .	7-37
7.2.2	Model 2 Single Tunnel (Full Section) . . . . .	7-43
7.2.3	Model 3 Two Tunnel (Symmetric Section) . . . . .	7-46
7.2.4	Model 4 Two Tunnel (Unsymmetric Section). . . . .	7-49
7.3	CIRCLE-2D. . . . .	7-52
7.4	PRESMAP-3D.. . . .	7-58
7.5	CROSS-3D	
7.5.1	Model 1 . . . . .	7-64
7.5.2	Model 2 . . . . .	7-74
7.5.3	Model 3 . . . . .	7-83
7.6	GEN-3D. . . . .	7-92
7.7	PRESMAP-GP	
7.7.1	Ex1 3D Line/Surface/Volume Blocks . . . . .	7-117
7.7.2	Ex2 Surface with Corner Triangles . . . . .	7-139
7.7.3	Ex3 Circular Sector.. . . .	7-141
7.7.4	Ex4 Straight Line Sector. . . . .	7-143
7.7.5	Ex5 Surface and Line Element (1). . . . .	7-145
7.7.6	Ex6 Surface and Line Element (2). . . . .	7-147
7.7.7	Ex7 Surface and Line Element (3). . . . .	7-149
7.7.8	Ex8 Cement Soil Road . . . . .	7-151
7.7.9	Ex9 Tunnel in Spherical Geometry. . . . .	7-153
7.7.10	Ex10 Horseshoe Tunnel . . . . .	7-155
7.7.11	Ex11 Wedge Volume and Surface Block. . . . .	7-157
<b>8.</b>	<b>ADDRGN Example</b>	
8.1	ADDRGN-2D . . . . .	8-1
8.1.1	Combining Meshes . . . . .	8-2
8.1.2	Modifying Mesh. . . . .	8-5
8.1.3	Generating Mesh . . . . .	8-9
8.2	ADDRGN-3D . . . . .	8-27
8.2.1	Combining Meshes . . . . .	8-27
8.2.2	Modifying Mesh . . . . .	8-32
<b>9.</b>	<b>SUPPLEMENT Example</b>	
9.1	XY Example Problem . . . . .	9-1
9.2	CARDS Example Problem. . . . .	9-4

<b>10. LOAD Example</b>	
10.1 LOAD-2D .....	10-1
10.2 LOAD-3D .....	10-15
<b>11. XY Graph Example</b>	
11.1 New Graph . . . . .	11-2
11.2 SMAP Result . . . . .	11-9
<b>12. SWCC Example</b>	
12. SWCC Example Problem .....	12-1



## Introduction

Example Problems are mainly provided:

- To give you some guide in preparing input data.
- To demonstrate the validity of SMAP programs.

Section 2 describes methods of preparing Mesh Files which represent the geometry of structures to be analyzed.

Section 3 describes two different methods of running main- and post-processing programs.

Section 4 illustrates SMAP-W3 main example problems as summarized in Table 1.1. These example problems are presented to demonstrate the accuracy and validity of SMAP-W3 main- processing program.

Section 5 illustrates Group Mesh examples. Group Mesh Generator is a two dimensional CAD program specially designed to build group mesh which can be used to generate finite element mesh with the aid of program ADDRGN-2D.

Section 6 illustrates Block Mesh examples. Block Mesh Generator is a three dimensional CAD program specially designed to build block mesh which can be used to generate finite element mesh with the aid of program PRESMA-P-GP.

Section 7 illustrates PRESMA-P examples which are used to generate two and three dimensional Mesh Files.

Section 8 illustrates ADDRGN examples which are used to combine or modify existing Mesh Files. ADDRGN-2D has a powerful mesh generation feature as demonstrated in sub section 8.1.3.

Section 9 illustrates SUPPLEMENT examples which are useful to prepare input data for pre- and main-processing programs.

Section 10 illustrates LOAD examples which are used to generate external nodal loads in two and three dimensional coordinate systems.

Section 11 illustrates XY Graph examples. XY Graph is a two dimensional graph consisting of lines connecting each pair of data points, which can be plotted by PLOT-XY or Excel.

Section 12 illustrates SWCC examples. SWCC plots soil-water characteristic curves for van Genuchten (1980), Fredlund & Xing (1994) and Brutsaert (1966) & Gardner (1958).

Table 1.1 List of SMAP-W3 example problem

Problem Number	Project File Name	Description
1	VP1.dat	1-D Transient Linear Consolidation
2	VP2.dat	1-D Transient Infiltration
3	VP3.dat	Square Dam Under Rapid Drawdown
4	VP4.dat	Steady-State Radial Flow toward Well
5	VP5.dat	Transient Seepage Through Generic Levee
6	VP6.dat	Steady-State Seepage Through Earth Dam



## Pre-Processing Programs

Pre-Processing programs are mainly used to generate Mesh File described in Section 4.3 of SMAP-W3 User's Manual. The Mesh File represents the geometry of the structure to be analyzed. This file contains information about nodal coordinates, element indexes, material property numbers, and boundary codes. In SMAP-W3, you may generate such Mesh Files using the following methods:

### Method 1

First, generate 2D Mesh File representing a typical two dimensional section using Group Mesh Generator, Block Mesh Generator, or 2D PRESMAP. Modify this 2D Mesh File using ADDRGN-2D if you need to do it. And then extend the 2D mesh into 3D mesh using GEN-3D.

1. Generate 2D Mesh File

GROUP MESH GENERATOR  
BLOCK MESH GENERATOR  
PRESMAP-2D    NATM-2D  
CIRCLE-2D    PRESMAP-GP

2. Modify 2D Mesh File

ADDRGN-2D

3. Extend into 3D Mesh File

GEN-3D

## Method 2

Generate 3D Mesh Files using Block Mesh Generator or 3D PRESMAP. Then combine or modify these 3D Mesh Files using ADDRGN-3D if you need to do it.

1. Generate 3D Mesh File

BLOCK MESH GENERATOR  
PRESMAP-3D CROSS-3D  
PRESMAP-GP

2. Combine or modify 3D Mesh File

ADDRGN-3D

Above two methods can be combined to make a final 3D Mesh File representing the structure to be analyzed.

To view the Mesh Files, you can use PLOT-3D by selecting following order:  
Plot → Mesh → F. E. Mesh → Open

Boundary codes can affect analysis result significantly so that it is strongly recommended for you to double check those codes to avoid solving wrong problems.

## Main- and Post-Processing Programs

Main-Processing program reads Mesh and Main Files as input and performs seepage analysis. Post-Processing programs read Post File along with analysis results from Main-Processing program and then produce graphical output.

Mesh Files can be generated using Pre-Processing programs as outlined in the previous Section 2. Main and Post Files can be created according to Section 4.4 and 4.5, respectively, in SMAP-W3 User's Manual. Normally, they can copy existing Main or Post Files which are similar to the problem to be analyzed and modify those files using Text Editor.

Main- and Post-Processing programs can be executed using the following methods:

### Method 1

Prepare Mesh, Main, and Post Files. Run **EXECUTE** menu to get analysis results. And run **PLOT** menu to view graphical output of analysis results.

1. Prepare All Input Files

Mesh, Main and Post Files

2. Get Analysis Results

RUN → SMAP → EXECUTE

3. View Graphical Output

PLOT → RESULT → PLOT-XY, PLOT-2D, PLOT-3D

### Method 2

Prepare Mesh, Main, and Blank Post Files. Run **EXECUTE** menu to get analysis results. Now, prepare Post File according to Section 4.5 in SMAP-W3 User's Manual. Run **PRE EXECUTE** menu to obtain intermediate plotting information files. And then run **PLOT** menu to view graphical output of analysis results. Note that Blank Post File consists of following 3 lines:

```
┌ 0, 1, 2
├ 0
└ 0, 4.5
```

1. Prepare Mesh and Main Files

[Mesh, Main and Blank Post Files](#)

2. Get Analysis Results

[RUN → SMAP → EXECUTE Menu](#)

3. Prepare Post File

[Post File in Section 4.5 of User's Manual](#)

4. Get Plotting Information Files

[RUN → SMAP → PreEXECUTE](#)

5. View Graphical Output

[PLOT → RESULT → PLOT-XY, PLOT-2D, PLOT-3D](#)

Method 2 is particularly useful when you are running large problems which take long execution time. You have to care in preparing Card Group 10 in Main File since Post File can only address those data requested in Card Group 10. You can repeat Steps 3 and 4 as long as your Post File addresses the output data within the range specified in Card Group 10 in Main File.

Post-Processing programs are mainly used to show graphical output of the analysis results.

PLOT-XY reads Card Group 12 in Post File and plots time histories of stresses, strains, and displacements. Once you run PLOT-XY , you will obtain intermediate plotting information file (PLOTXY.Lin). PLOTXY.Lin file can be modified as it will be described in Section 11 of SMAP Examples.

PLOT-2D reads Card Group 11 in Post File and plots two dimensional snapshots. Once you run PLOT-2D in PLOT menu, you will obtain intermediate plotting information file (PLOT2D.DAT).

PLOT-3D does not need any Post File.

This program plots following three dimensional snapshots:

- Finite element mesh
- Darcy flow velocity vector
- Contours of total head, water pressure, and flow rate
- 3D iso surface



## SMAP-W3 Example Problem

SMAP-W3 is the main-processing program which computes seepage analysis of three-dimensional problems. Input parameters of SMAP-W3 are described in detail in Section 4 of SMAP-W3 User's Manual.

Running SMAP-W3 is described in Section 3.2.1 of User's Manual and can be selected in the following order:

**RUN → SMAP → EXECUTE**

Manual procedure to run SMAP-W3 is outlined in Section 3.5 of User's Manual. Once you finished execution of SMAP-W3, you can obtain graphical outputs by selecting:

**PLOT → RESULT → PLOT-XY, PLOT-2D, or PLOT-3D**

**PLOT** Menu is described in Section 3.3 of SMAP-W3 User's Manual.

Table 1.1 in Section 1 shows the summary of SMAP-W3 example problems. These example problems are the verification problems. The main objective of these verification problems is to demonstrate the accuracy and validity of SMAP-W3.

You can access all input files of example problems in the directory:

**C:\Smap\Smaw3\Example\Smaw**

For each example problem, brief problem descriptions and partial graphical outputs will be presented in this section. References used in example problems are listed at [Sec. 4 in SWAP-W3 Theory](#).

### 4.1 1-D Transient Linear Consolidation

The first verification problem concerns one-dimensional transient linear consolidation through saturated soil which is the same problem as in Verification Problem 2 in SMAP-3D Example. A soil column shown in Figure 4.1 is assumed that it is liquefied initially and pore water takes all the weight. Thus the excess pore water pressure is dissipated through the top free surface over time. Soil properties used for SMAP-W3 are shown in Figure 4.1.

The exact solution is described in detail in VP2 in SMAP-3D Example.

Table 4.1 shows the listing of main input file VP1.Man. Two different finite element meshes are considered to see the influence of element types. The hexa mesh in Figure 4.2 consists of 20 eight-node hexahedral elements and the prism mesh in Figure 4.3 consists of 40 six-node prism elements. Boundary codes and initial total heads are shown in Figures 4.4 and 4.5, respectively.

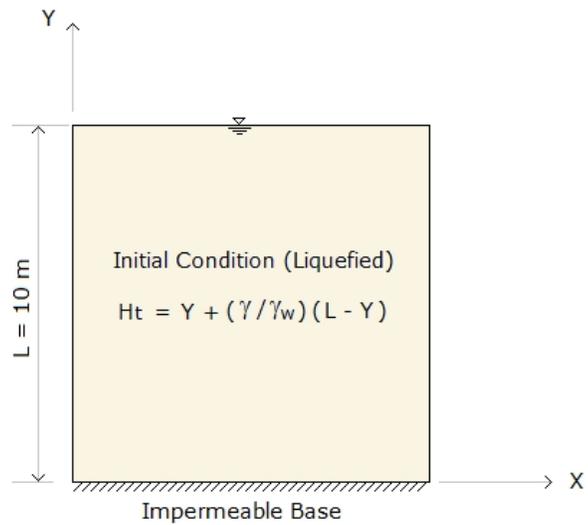
Following are the partial listing of graphical outputs:

Figure 4.6 Water pressure contour at  $T = 0.05$

Figure 4.7 Water pressure contour at  $T = 0.5$

Figure 4.8 Water pressure profiles at  $T = 0.05$  and  $0.5$

Computed total head profiles are compared with the exact solution by Terzaghi. Results from all cases match very closely with the exact solution.



$$k = 0.001 \text{ m/d} \quad E = 1000 \text{ t/m}^2 \quad \nu = 0.3$$

$$\gamma_w = 1.0 \text{ t/m}^3 \quad n = 0.3 \quad G_s = 2.7$$

$$M = (1 - \nu) E / ((1 + \nu) (1 - 2\nu)) = 1346 \text{ t/m}^2$$

$$M_w = 1 / M = 7.429 \times 10^{-4} \text{ m}^2 / \text{t}$$

$$\gamma = \gamma_w (n + G_s (1 - n)) = 2.19 \text{ t/m}^3$$

$$C_v = k M / \gamma_w = 1.346 \text{ m}^2 / \text{d}$$

$$T = C_v t_m / L^2 = 0.0136 t_m$$

Figure 4.1 1-D transient linear consolidation for VP1

## 4-4 SMAP-W3 Example Problem

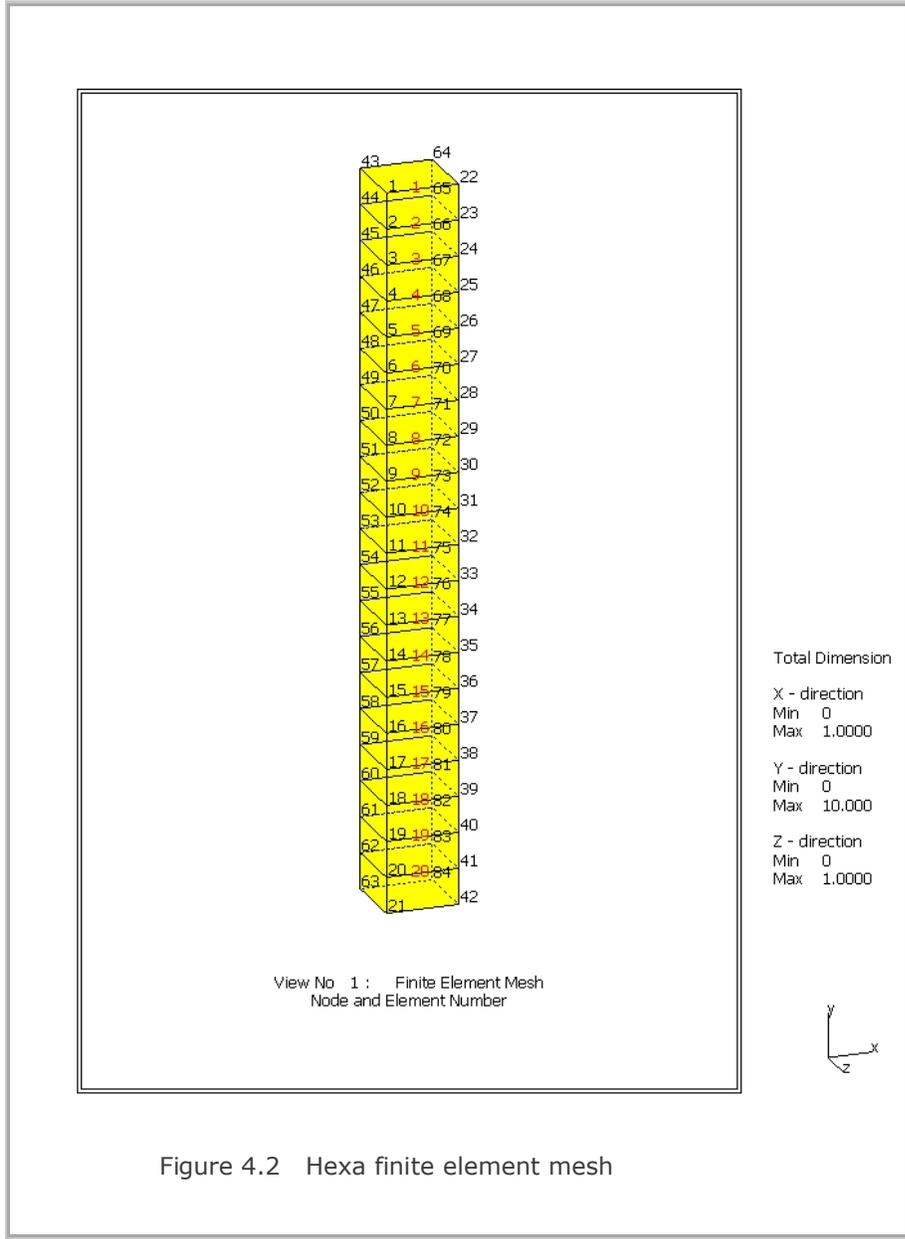
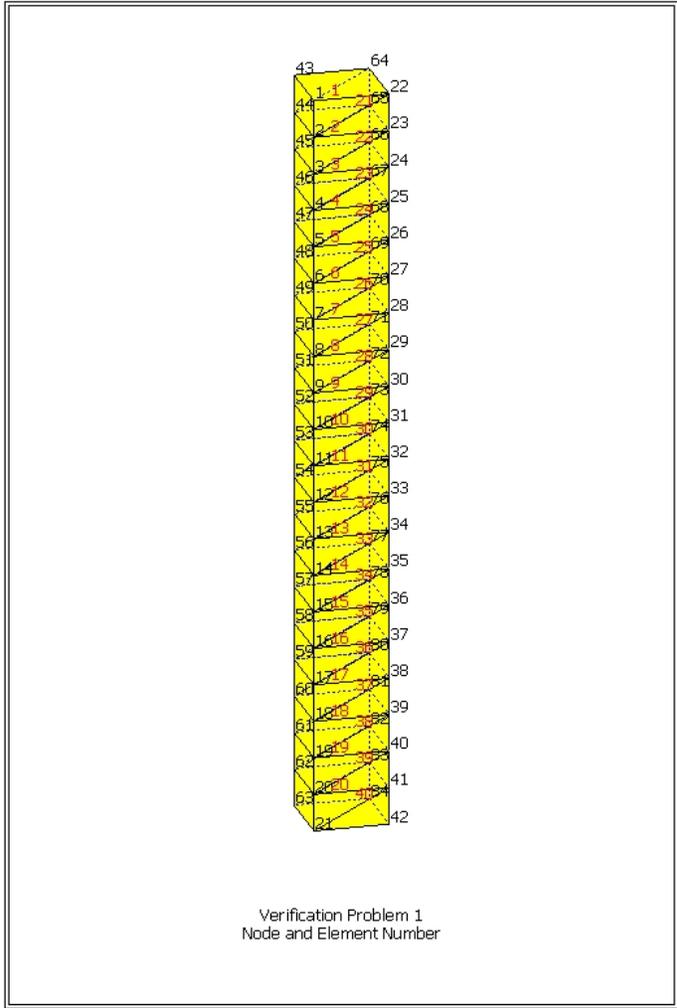


Figure 4.2 Hexa finite element mesh



Total Dimension

X - direction  
Min 0  
Max 1.0000

Y - direction  
Min 0  
Max 10.0000

Z - direction  
Min 0  
Max 1.0000



Figure 4.3 Prism finite element mesh

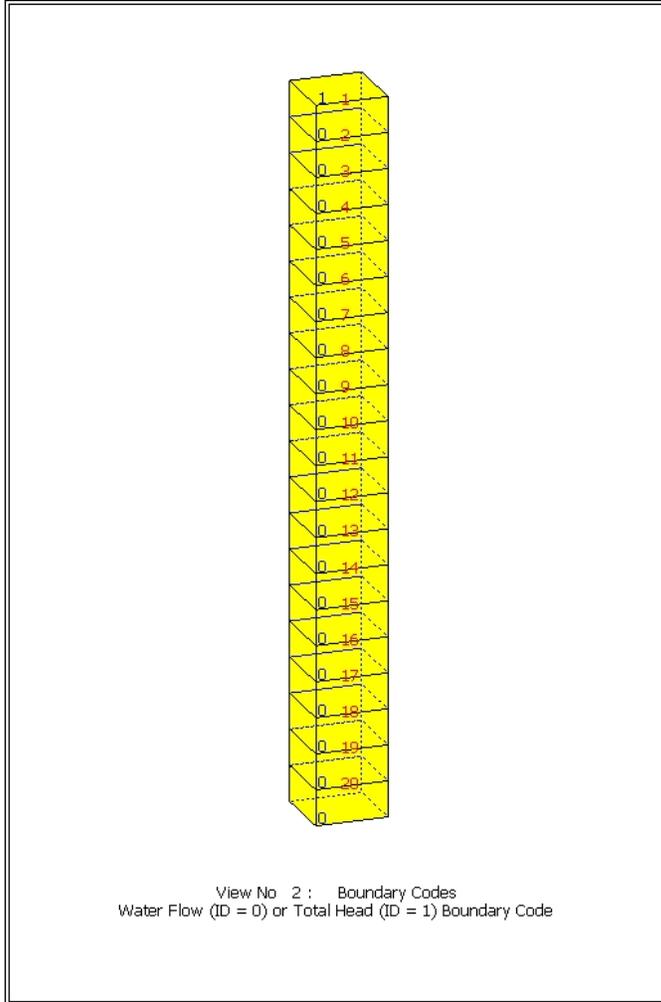
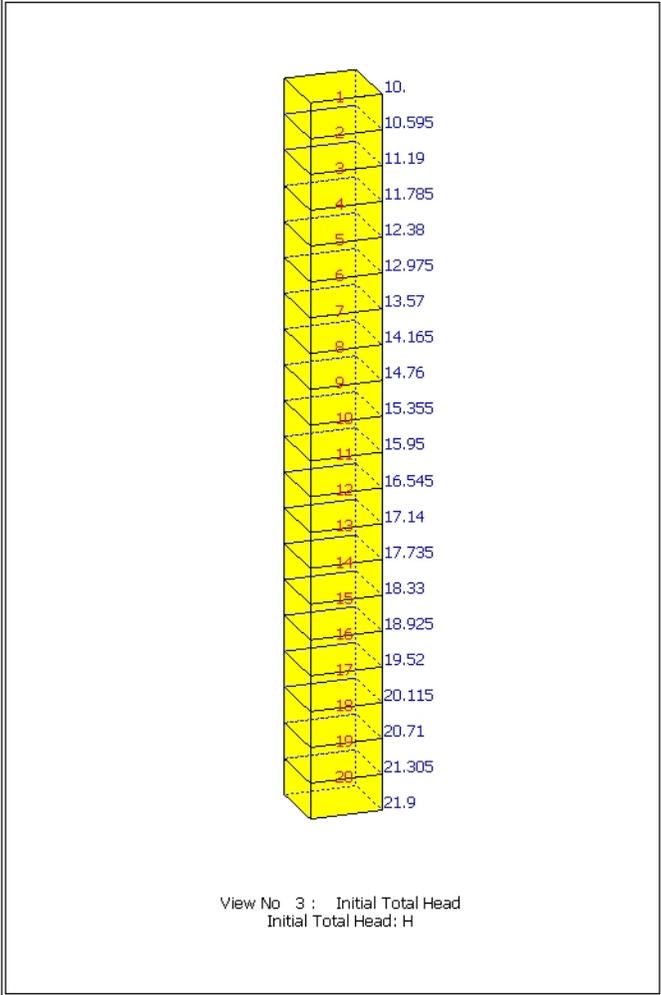


Figure 4.4 Boundary codes



Total Dimension

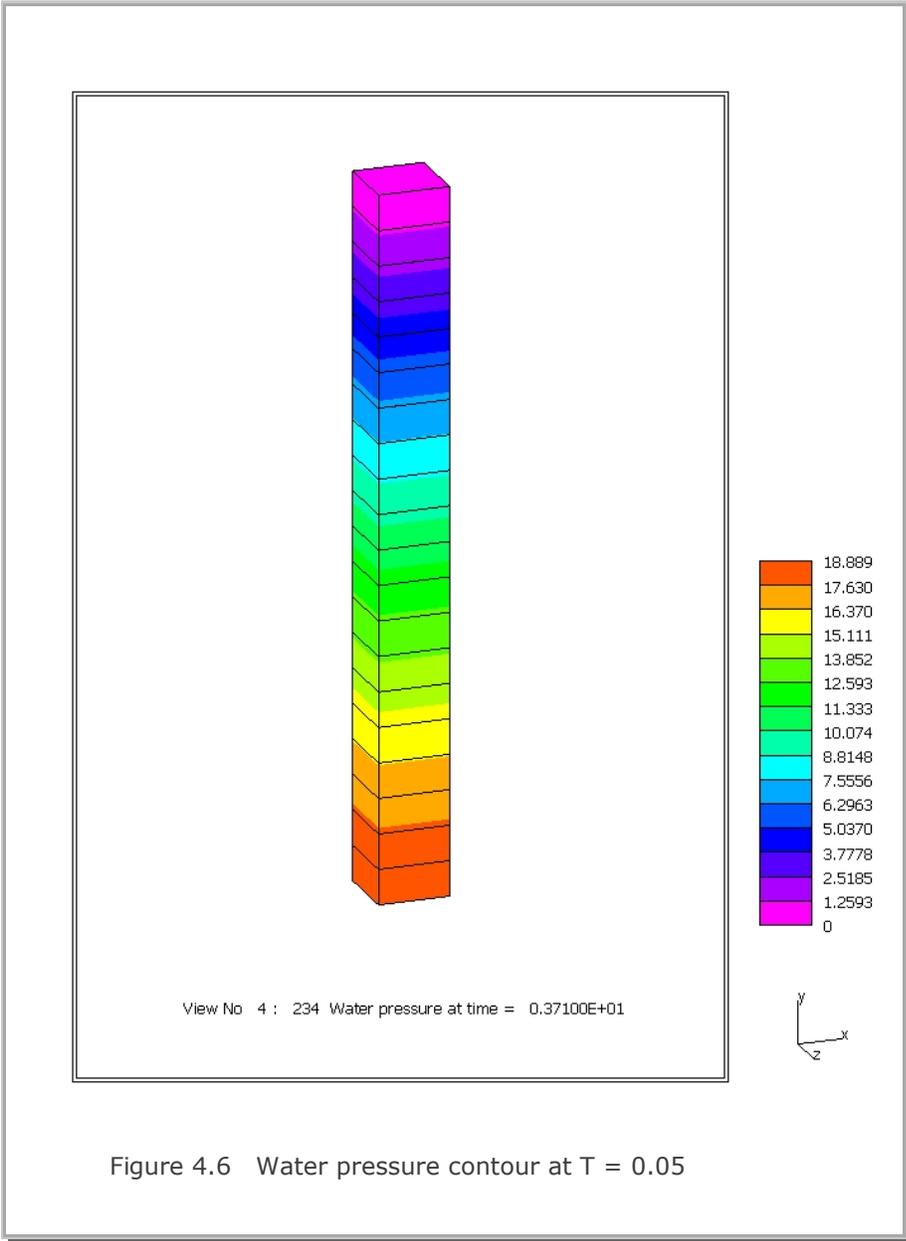
X - direction  
Min 0  
Max 1.0000

Y - direction  
Min 0  
Max 10.000

Z - direction  
Min 0  
Max 1.0000



Figure 4.5 Initial total heads



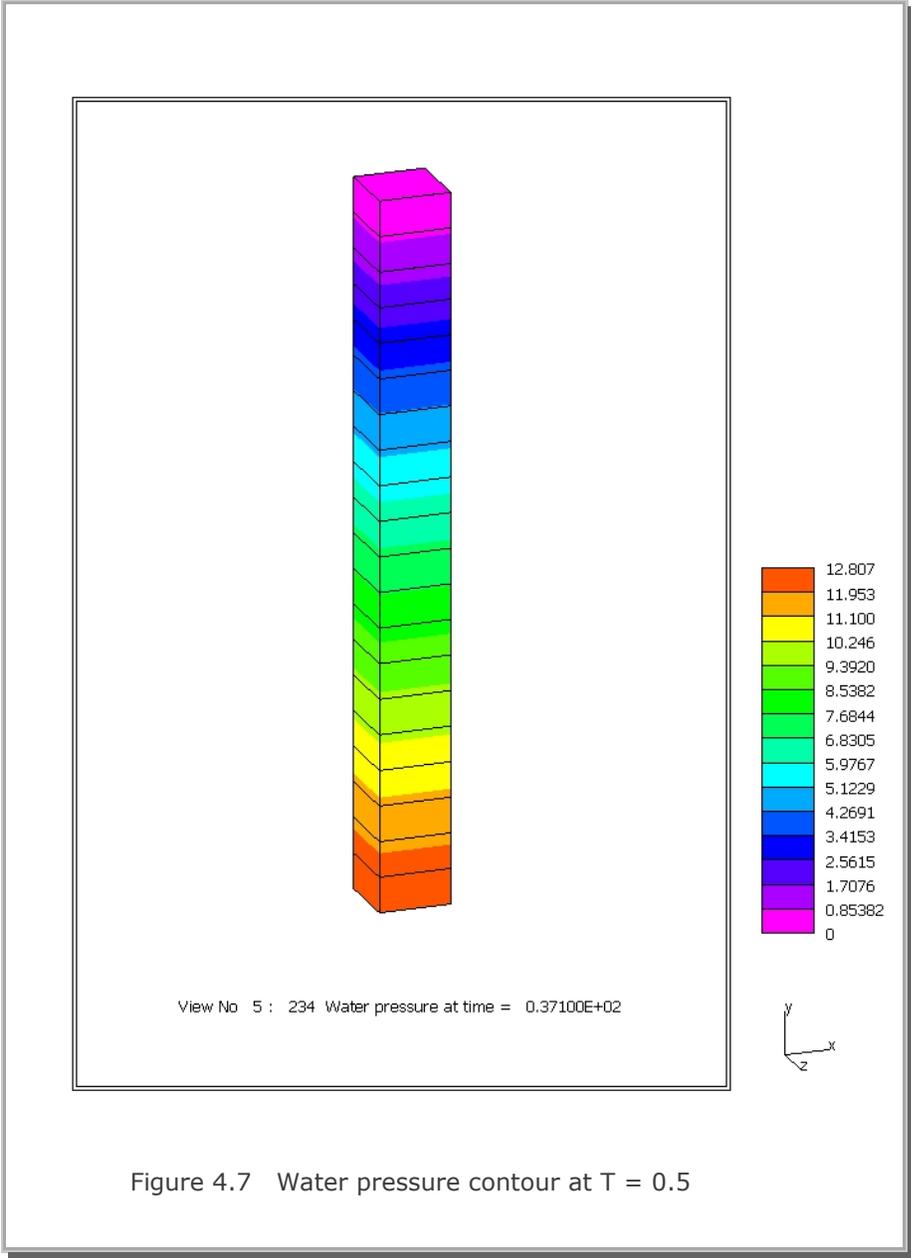


Figure 4.7 Water pressure contour at T = 0.5

## 4-10 SMAP-W3 Example Problem

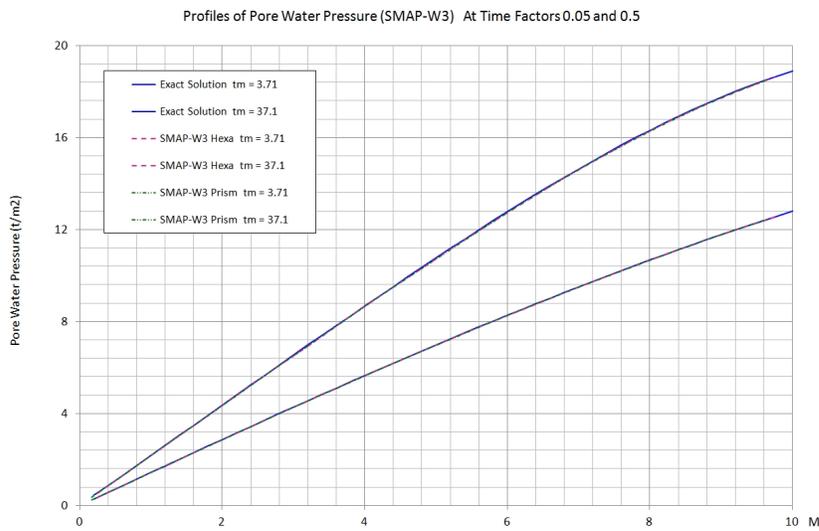


Figure 4.8 Water pressure profiles at  $T = 0.05$  and  $0.5$

Table 4.1 Listing of main input file VP1.Man

```

* CARD 1.1
* TITLE
  Verification Problem 1
* CARD 2.1
* IP  ILUMP  IBATCH  ISST  IMSEEP  IDFVEL  IFVOL  ISFACE
  1   1      -1      1     0        0        1      1
* CARD 3.1
* NCYCL NSTCL  NITER  MCYCL  TOLER  IRANGE  IRNODE
  3720  0      1      1     0.01    0        0
* CARD 3.2
* SIP
  1.0
* CARD 3.2.1
* IDELT  DT
  0      0.01
* CARD 5.1
* NCONT
  20
* CARD 5.2.1
* NMAT
  1
* CARD 5.2.2.1
* TITLE
  MATERIAL 1
* CARD 5.2.2.2
* MATNO  MATFN  MW(m2/t)  GW(t/m3)  KH(m/d)  KV(m/d)  THETA
  1      0      7.429E-04  1.      0.001    0.001    0.
* CARD 9.4.1
* NTIMF  NTIM
  1      2
* CARD 9.4.2
* TIME  FN1
  0.0   10.
  100.  10.
* CARD 9.5.1
* NWPRF  NWPR  IWPF  INTP
  0      0      0      0
* CARD 10.1
* NTPRNT
  1

```

## 4-12 SMAP-W3 Example Problem

---

```
* CARD 10.2.1
* NHPEL
  1
* CARD 10.2.2
* NEL1
  20
* CARD 10.3.1
* NHPMT
  1
* CARD 10.3.2
* NODE1
  21
* CARD 10.4.1
* NTIME
  2
* CARD 10.4.2
* TIME1    TIME2
  3.71    37.1
* CARD 10.5.1
* NPHD     ZEFS
  0        1.
* CARD 10.6.1
* NTHD
  0
* CARD 10.7.1
* NFLN     ISPL     DELV
  0        1        0.0
* CARD 10.8
* NFSEC    IBFQ
  0        1
* END OF DATA
```

## 4.2 1-D Transient Infiltration

The second verification problem concerns a one-dimensional transient infiltration through unsaturated soil. A soil column shown in Figure 4.9, initially unsaturated with uniformly distributed residual water content, is subjected to constant infiltration at the top of soil column while it keeps constant residual water content at the bottom of column. Thus water is flowing down through unsaturated soil. Soil properties used for SMAP-W3 are shown in Figure 4.9.

Both unsaturated volumetric water content and unsaturated hydraulic conductivity are modeled by simple Gardner (1958) equation which is described in detail in Section 3.1.5 in SMAP-W3 Theory.

Table 4.2 shows the listing of main input file VP2.Man. Three different finite element meshes are considered to see the influence of element sizes and element types. The standard mesh in Figure 4.10 consists of 125 eight-node hexahedral elements, the prism mesh in Figure 4.11 consists of 250 six-node prism elements and the double mesh in Figure 4.12 consists of 250 eight-node hexahedral elements.

Following are the partial listing of graphical outputs:

Figure 4.13 Total head profile at time 1 day

Figure 4.14 Total head profile at time 5 day

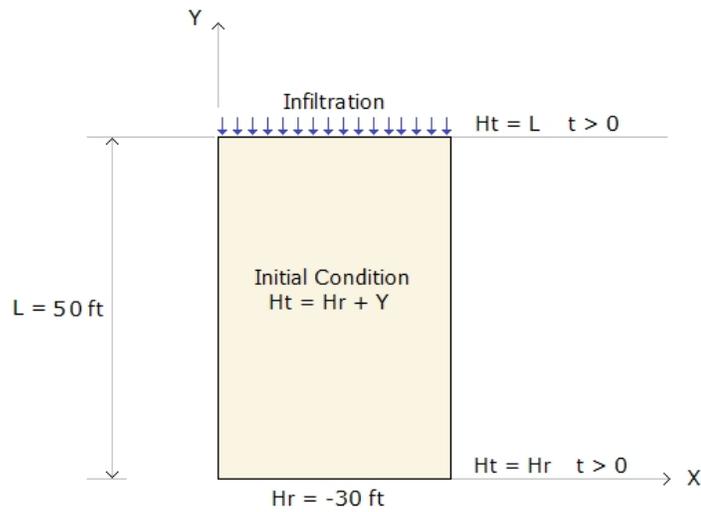
Figure 4.15 Water pressure contour at time 1 day

Figure 4.16 Water pressure contour at time 5 day

Computed total head profiles are compared with the analytic solution by Tracy et al. (2016), ERDC TR-16-8. Results from standard and prism meshes show slight deviation at time = 1 day but they are very close to analytic solution at time = 5 day. Results from double mesh mach very closely with the analytic solution even at early time.

For other analyses with different optional parameters, refer to the file [VP2 Optional Analyses W3.pdf](#).

4-14 SMAP-W3 Example Problem



Saturated Soil Properties :

$$k = 0.1 \text{ ft/d} \quad M_w = 1 \times 10^{-5} \text{ ft}^2/\text{lb}$$

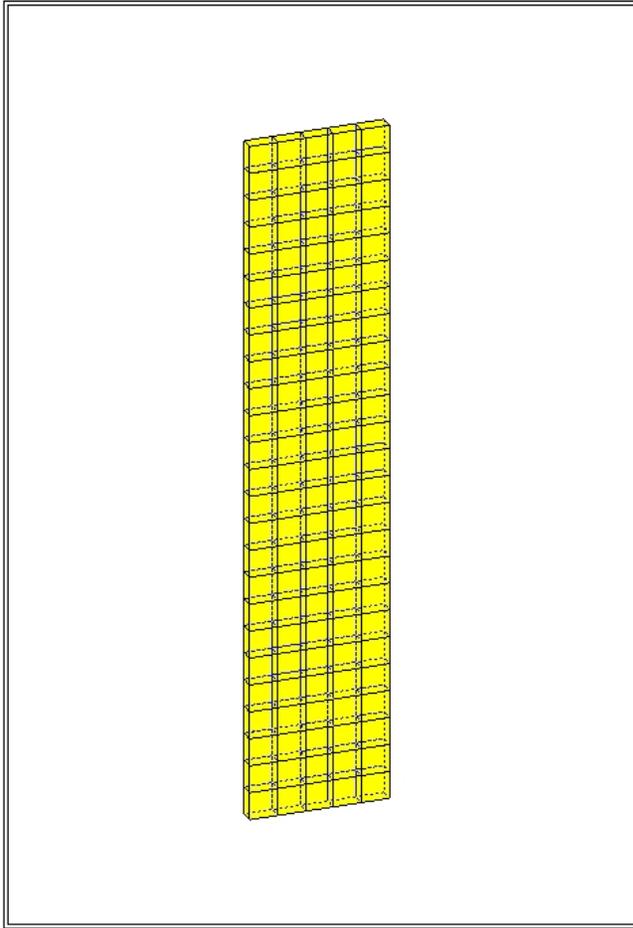
Unsaturated Volumetric Water Content (Gardner, 1958)

$$\theta_s = 0.45 \quad \theta_r = 0.15 \quad \alpha = 0.1 \text{ ft}^{-1}$$

Unsaturated Hydraulic Conductivity (Gardner, 1958)

$$k_s = 0.1 \text{ ft/d} \quad \alpha = 0.1 \text{ ft}^{-1}$$

Figure 4.9 1-D transient infiltration for VP2



Total Dimension

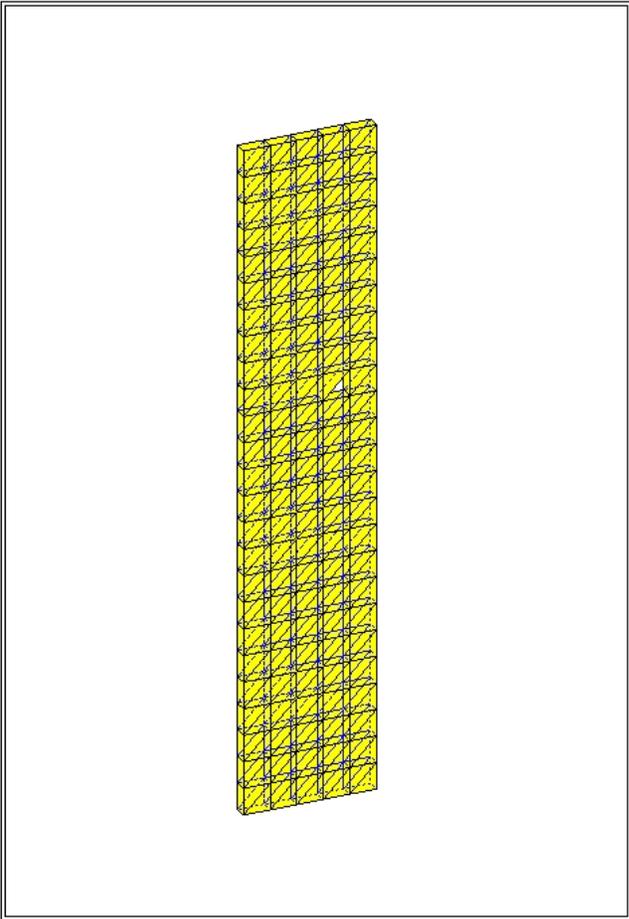
X - direction  
Min 0  
Max 10.000

Y - direction  
Min 0  
Max 50.000

Z - direction  
Min 0  
Max 1.0000



Figure 4.10 Standard finite element mesh



Total Dimension

X - direction  
Min 0  
Max 10.000

Y - direction  
Min 0  
Max 50.000

Z - direction  
Min 0  
Max 1.0000



Figure 4.11 Prism finite element mesh

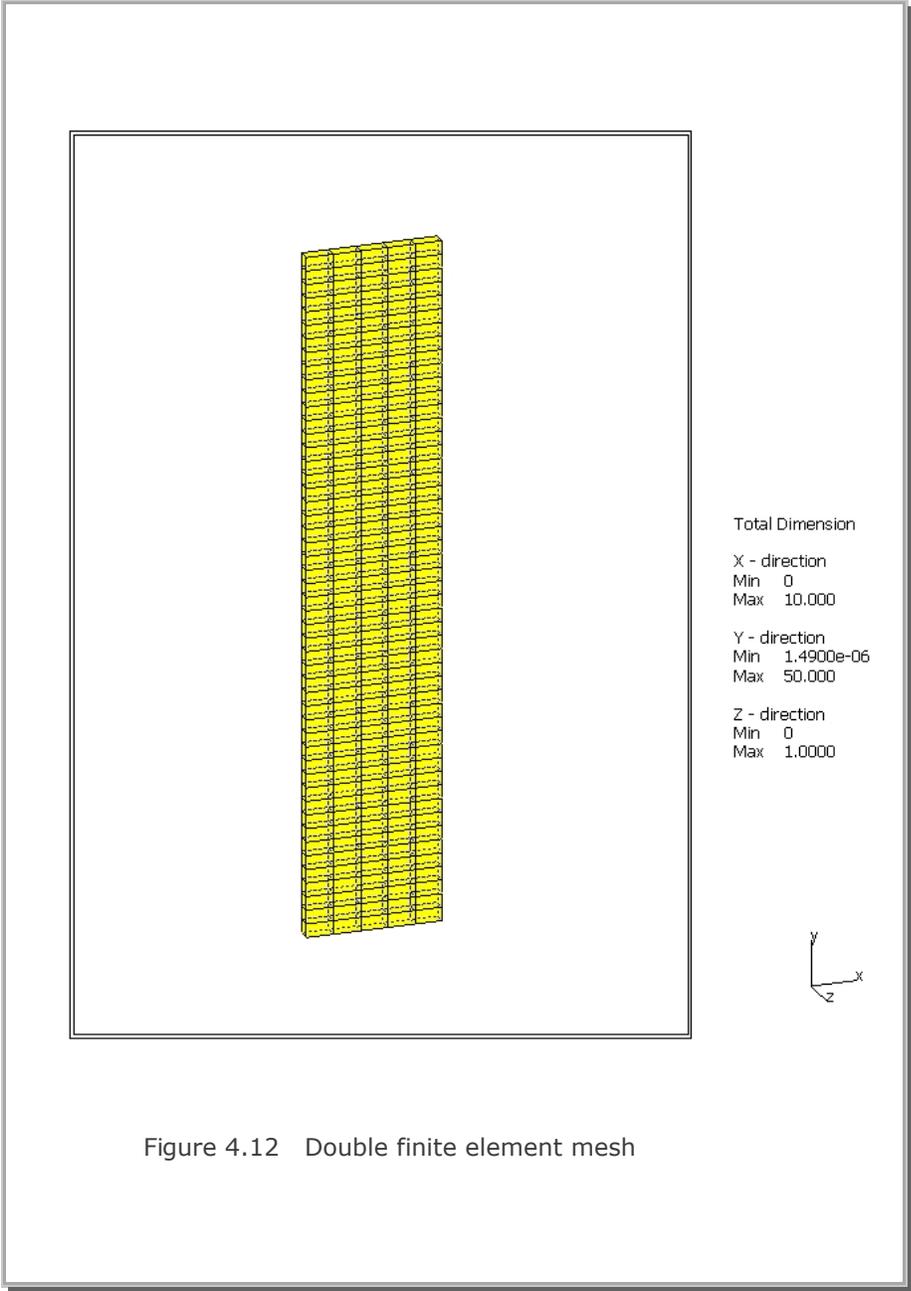


Figure 4.12 Double finite element mesh

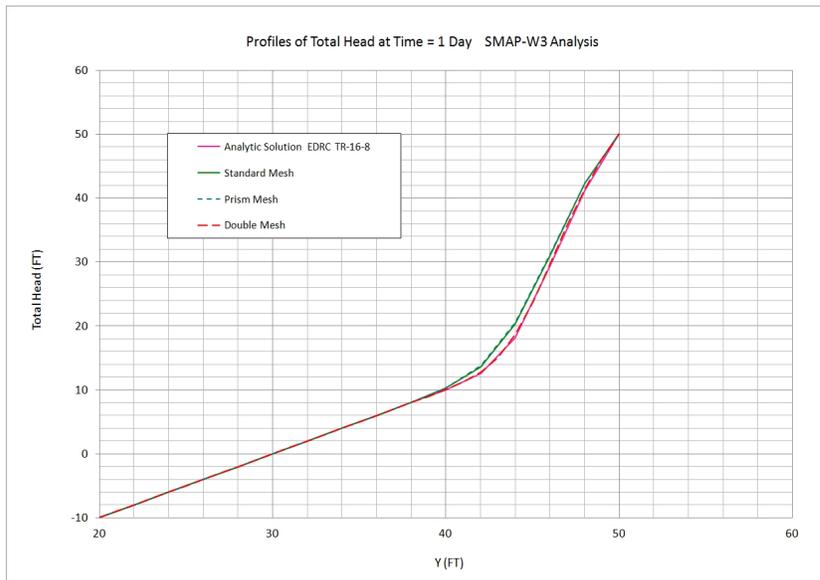


Figure 4.13 Total head profile at time 1 day

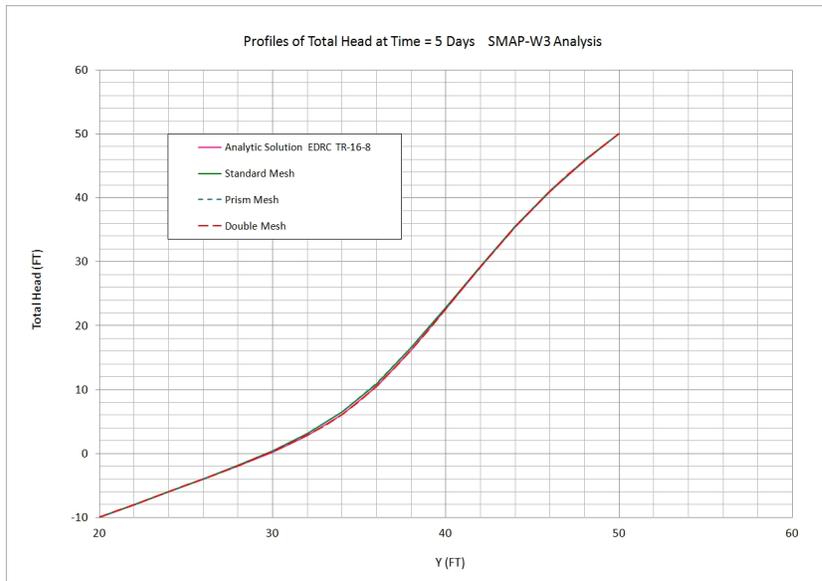


Figure 4.14 Total head profile at time 5 day

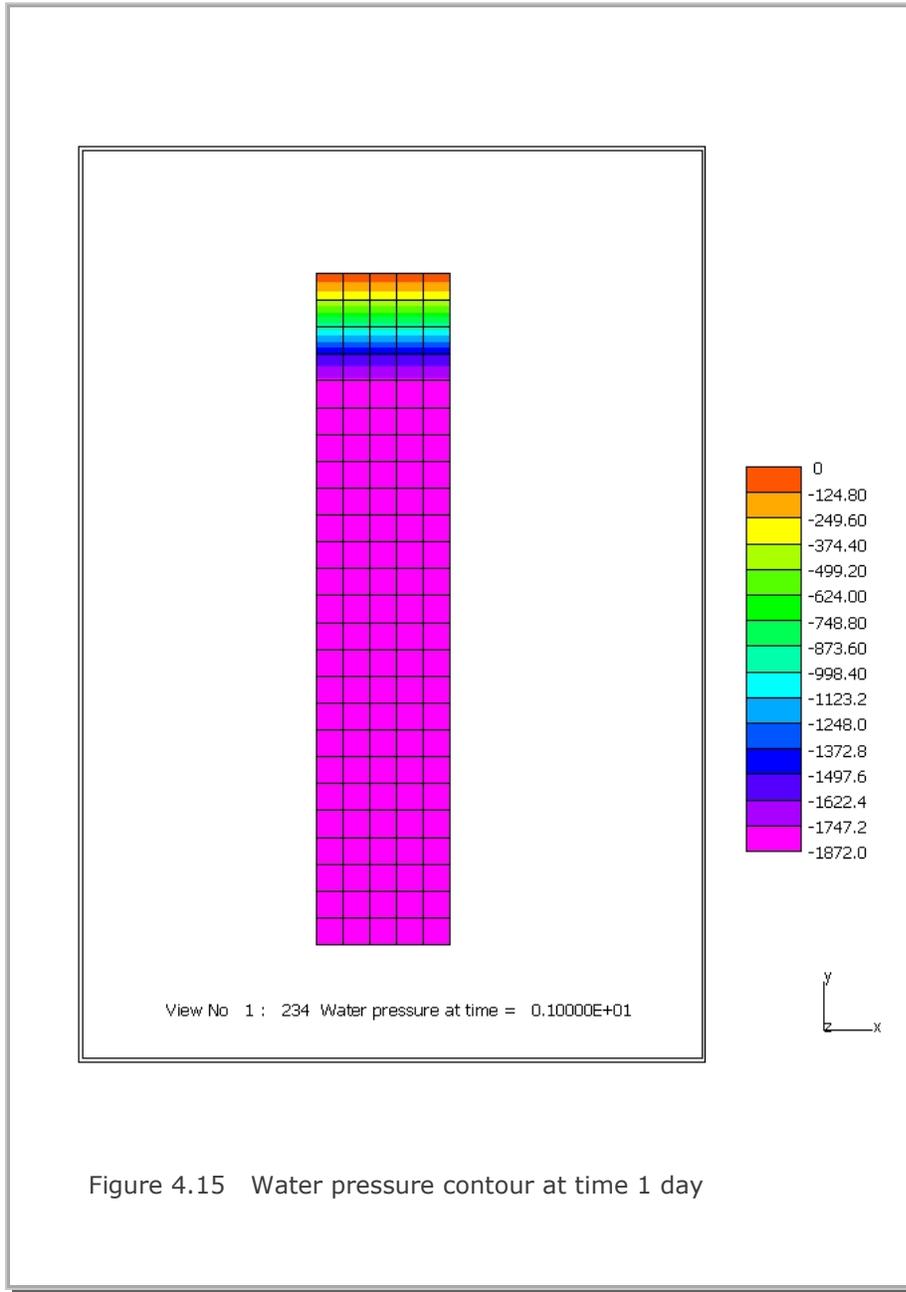


Figure 4.15 Water pressure contour at time 1 day

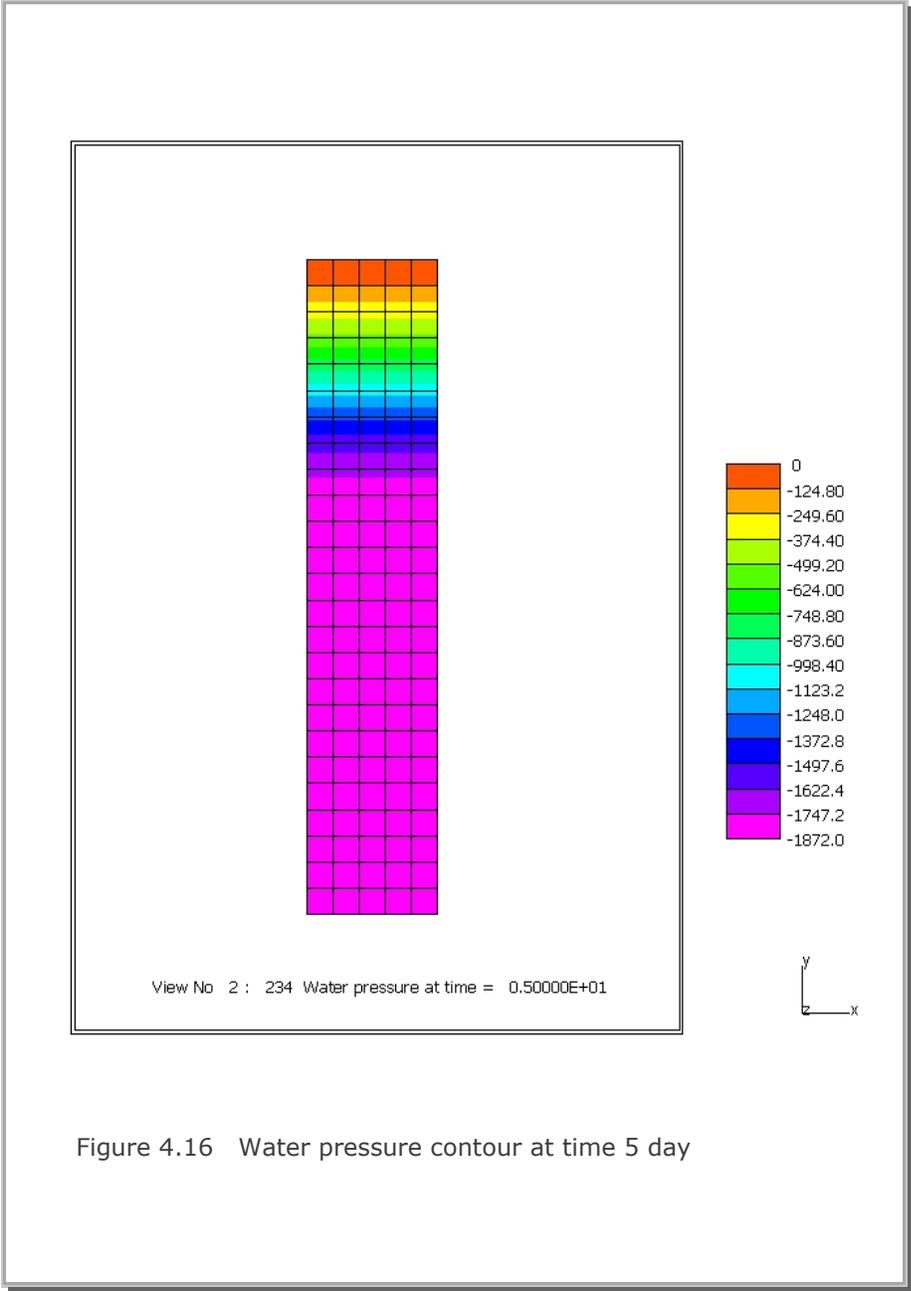


Figure 4.16 Water pressure contour at time 5 day

**4-22** SMAP-W3 Example Problem

Table 4.2 Listing of main input file VP2.Man

```

* CARD 1.1
* TITLE
Verification Problem 2
* CARD 2.1
* IP  ILUMP  IBATCH  ISST  IMSEEP  IDFVEL  IFVOL  ISFACE
1  1  -1  1  0  0  1  1
* CARD 3.1
* NCYCL  NSTCL  NITER  MCYCL  TOLER  IRANGE  IRNODE
5000  0  20  1  0.01  0  0
* CARD 3.2
* SIP
1.0
* CARD 3.2.1
* IDELT  DT
0  0.001
* CARD 5.1
* NCONT
125
* CARD 5.2.1
* NMAT
1
* Simple Gardner Equation (1958) applied for both K and Mw
* To simulate example in Section 6 in ERDC TR-16-8
* CARD 5.2.2.1
* TITLE
MATERIAL 1
* CARD 5.2.2.2
* MATNO  MATFN  MW(ft2/lb)  GW(lb/ft3)  KH(ft/d)  KV(ft/d)  THETA
1  11  1.0E-05  62.4  0.1  0.1  0.
* CARD 5.2.2.3
* VWCsat  VWCres  alpha(1/ft)  n  m  Uswcc  SCFac  Gwm  Pr
0.45  0.15  0.1  0.  0.  1  1.  62.4  0.
* CARD 9.4.1
* NTIMF  NTIM
2  2
* CARD 9.4.2
* TIME  FN1  FN2
0.0  50.  -30.
1000.  50.  -30.
* CARD 9.5.1
* NWPRF  NWPR  IWPF  INTP
0  0  0  0

```

```
* CARD 10.1
* NTPRNT
  10
* CARD 10.2.1
* NHPEL
  4
* CARD 10.2.2
* NEL1  NEL2  NEL3  NEL4
  2     6     11    16
* CARD 10.3.1
* NHPMT
  4
* CARD 10.3.2
* NOD1  NOD2  NOD3  NOD4
  2     6     11    16
* CARD 10.4.1
* NTIME
  2
* CARD 10.4.2
* TIME1,  TIME2,  ...
  1     5
* CARD 10.5.1
* NPHD      ZEFS
  0         1.
* CARD 10.6.1
* NTHD
  0
* CARD 10.7.1
* NFLN      ISPL      DELV
  0         1         0.0
* CARD 10.8
* NFSEC      IBFQ
  0         1
* END OF DATA
```

### 4.3 Square Dam Under Rapid Drawdown

The third verification problem concerns a square dam under rapid drawdown of water table. A square dam shown in Figure 4.17, initially fully saturated, is subjected to instantaneous drawdown of left side water table from top surface to base. Saturated and unsaturated properties used for SMAP-W3 are shown in Figure 4.17.

Unsaturated volumetric water content is modeled by Brutsaert (1966) as shown in Figures 4.18 and 4.19. Unsaturated hydraulic conductivity is modeled by Gardner (1958) as shown in Figure 4.20. Both models are described in Section 3.1.4 in SMAP-W3 Theory.

Table 4.3 shows the listing of main input file VP3.Man. 256 equal sized 8-node elements have been used to model the square dam as shown in the finite element mesh in Figure 4.21. The left boundary of the dam represents potential seepage face which is varying during transient state while the right boundary keeps constant total head.

Following are the partial listing of graphical outputs:

Figure 4.22 Water pressure contour at time 1.89 day

Figure 4.23 Water pressure contour at steady state

Figure 4.24 Darcy flow velocity at time 1.89 day

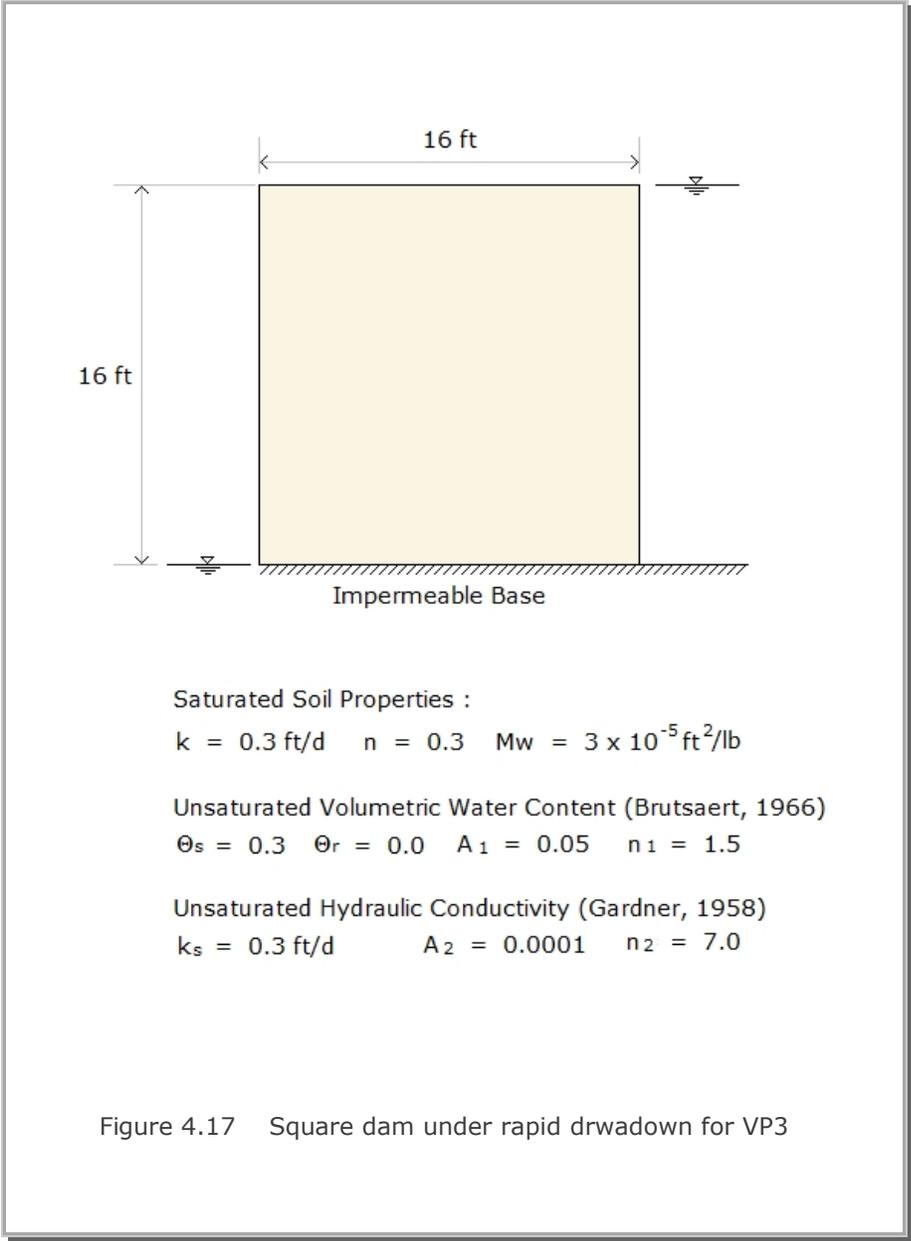
Figure 4.25 Darcy flow velocity at steady state

Figure 4.26 Phreatic surfaces during transient and steady states

Zero water pressure contour represents the phreatic surface which is the boundary between the saturated and unsaturated zones. This surface is moving down with time and remains constant over time. Flow velocity field shows very low velocity in unsaturated zone.

Computed phreatic surfaces are compared with the published studies by France et al. (1971) and Bathe and Khoshgoftaar (1979) in Figure 4.26. During the transient state, SMAP-W3 results are close to their results except the seepage face. However, SMAP-W3 result is very close to their results at steady state.

For other analyses with different optional parameters, refer to the file [VP3 Optional Analyses W3.pdf](#).



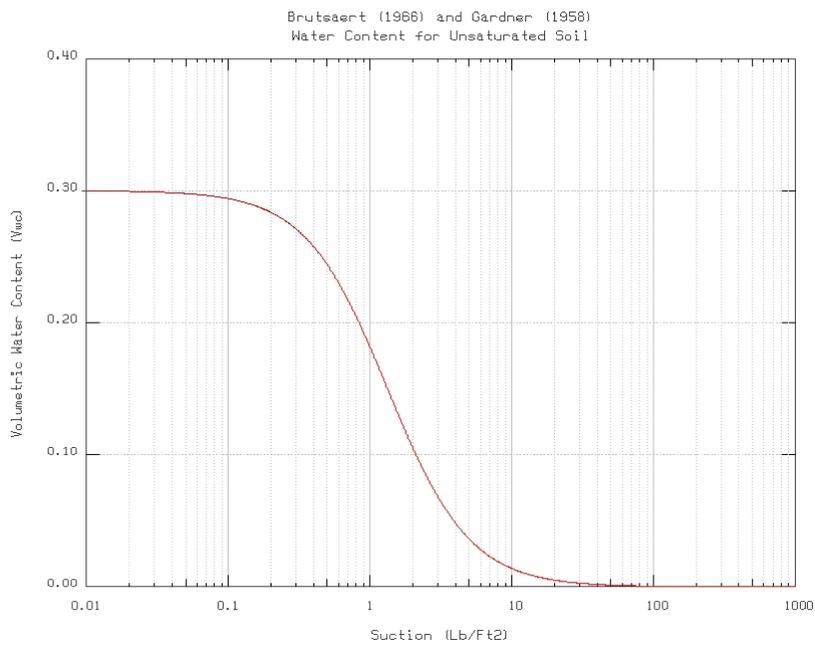


Figure 4.18 Unsaturated volumetric water content

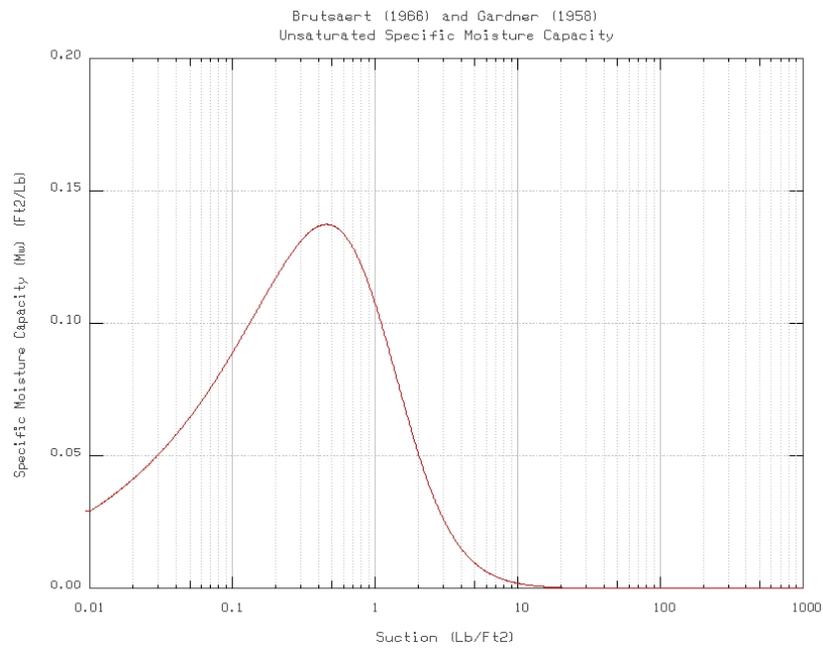


Figure 4.19 Unsaturated specific moisture capacity

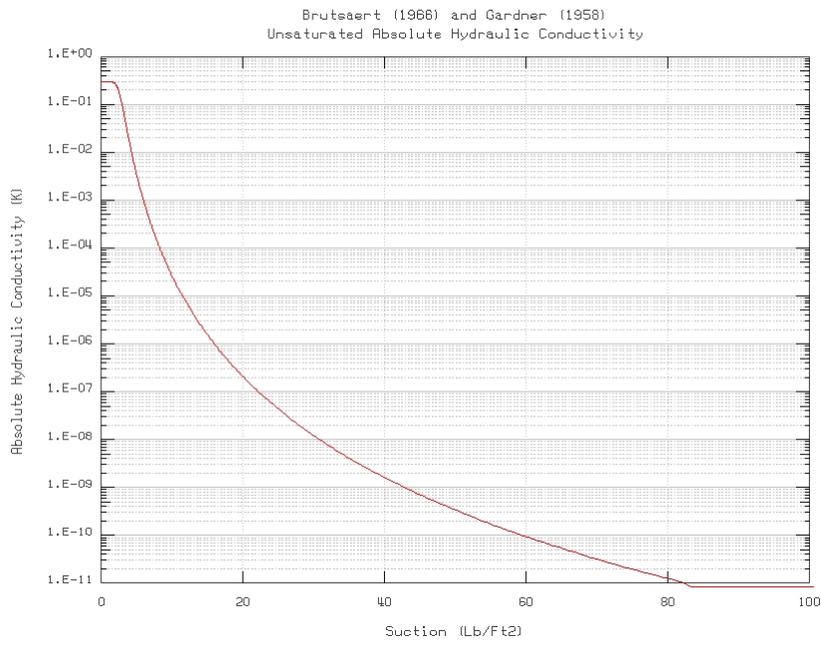


Figure 4.20 Unsaturated hydraulic conductivity

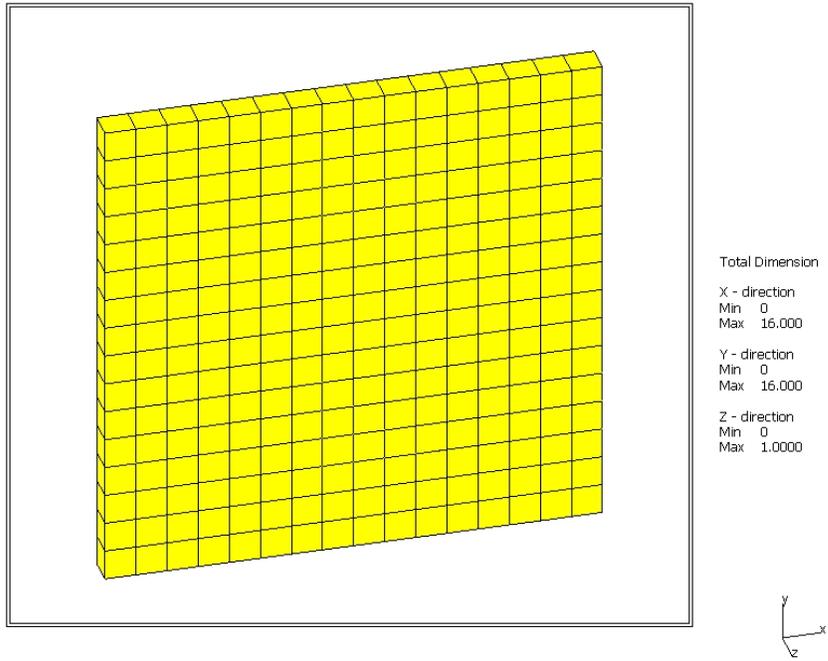
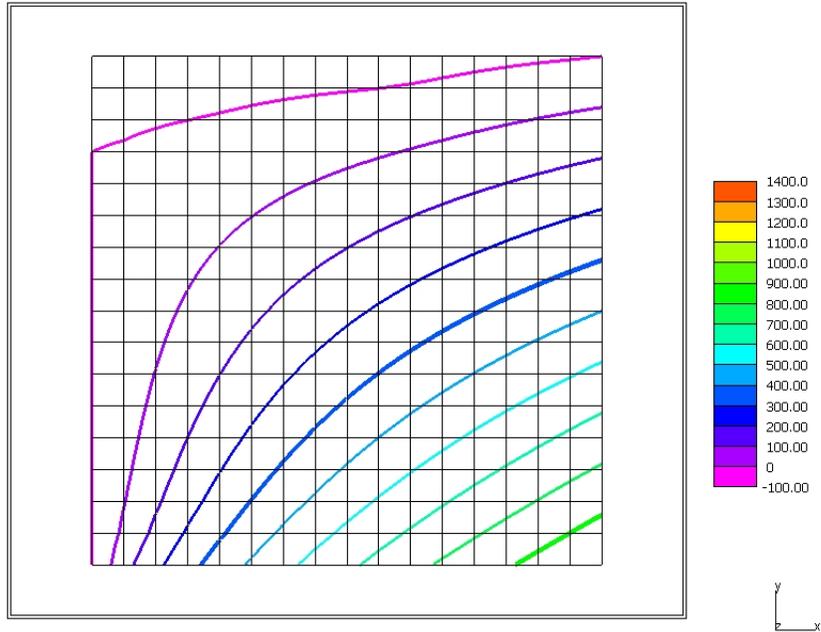
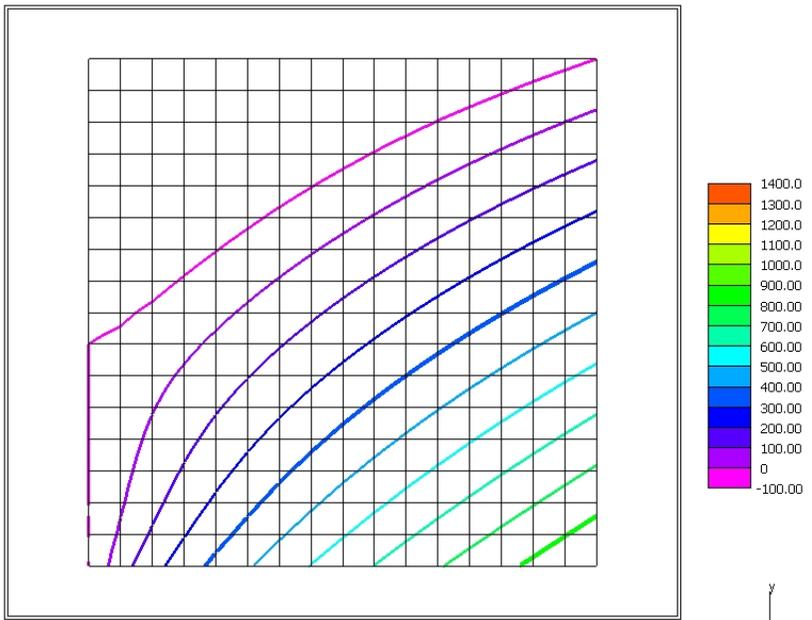


Figure 4.21 Finite element mesh for VP3



View No 4 : 234 Water pressure at time = 1.89000E+00

Figure 4.22 Water pressure contour at time 1.89 day



View No 1 : 234 Water pressure at time = 4.0000E+01

Figure 4.23 Water pressure contour at steady state

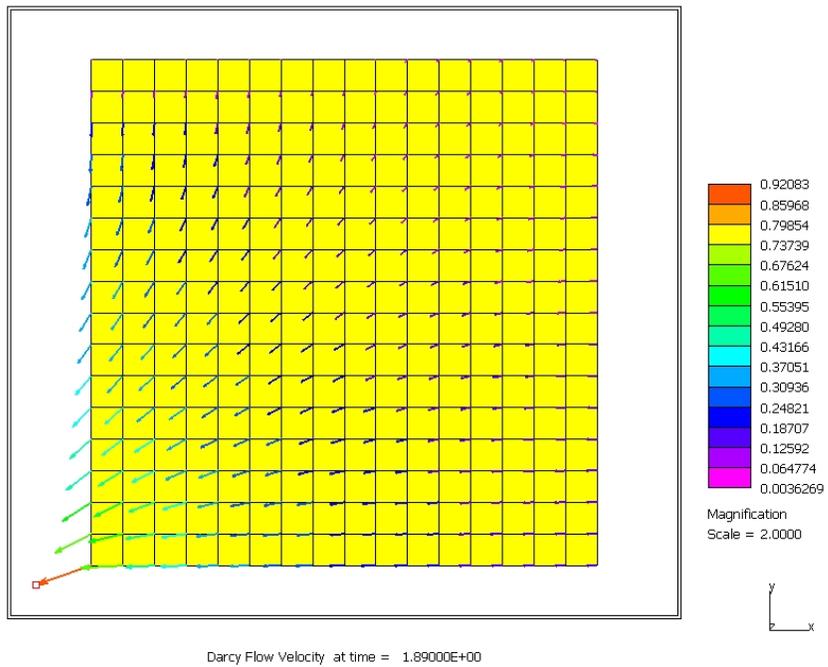


Figure 4.24 Darcy flow velocity at time 1.89 day

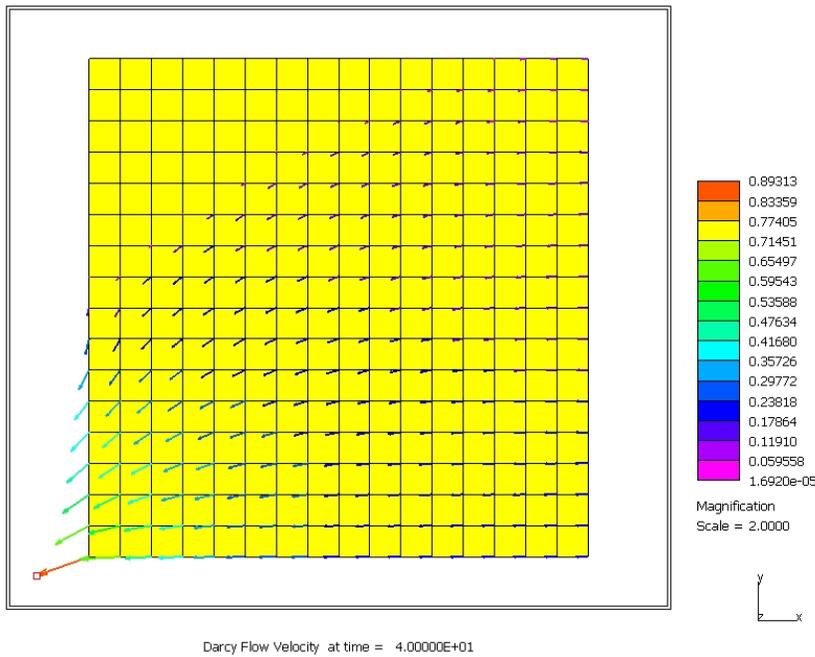


Figure 4.25 Darcy flow velocity at steady state

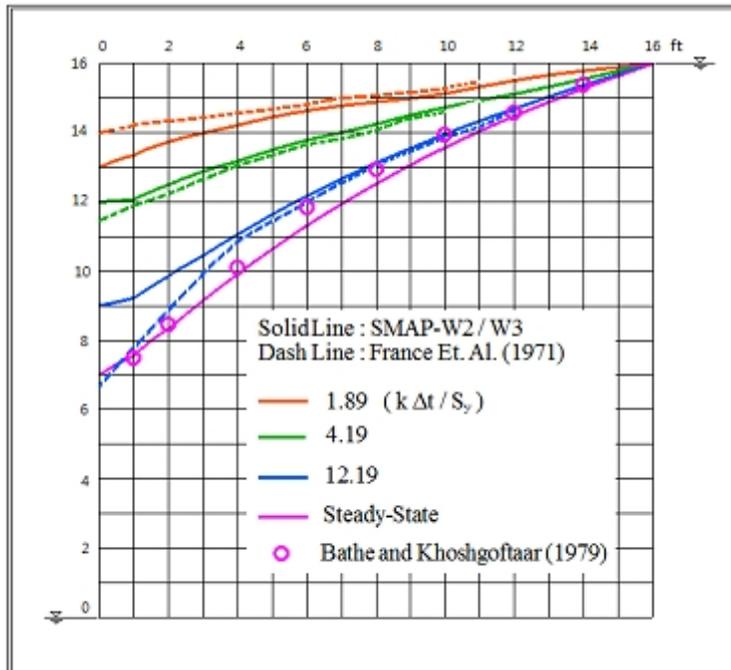


Figure 4.26 Phreatic surfaces during transient and steady states

Table 4.3 Listing of main input file VP3.Man

```

* CARD 1.1
* TITLE
  Verification Problem 3
* CARD 2.1
* IP  ILUMP  IBATCH  ISST      IMSEEP  IDFVEL  IFVOL  ISFACE
  1   1      -1      1        0        0       1     1
* CARD 3.1
* NCYCL NSTCL  NITER  MCYCL      TOLER  IRANGE  IRNODE
  4000  0      20     10        0.01   0       0
* CARD 3.2
* SIP
  0.5
* CARD 3.2.1
* IDELT  DT
  0      0.01
* CARD 5.1
* NCONT
  256
* CARD 5.2.1
* NTNC
  1
* MATFN = 13
* Gardner (1958) For Unsaturated Hydraulic Conductivity, K
* Brutsaert(1966) For Unsaturated Specific Moisture, Mw
* CARD 5.2.2.1
* TITLE
  MATERIAL 1
* CARD 5.2.2.2
* MATNO  MATFN  MW(ft2/lb)  GW(lb/ft3)  KH(ft/d)  KV(ft/d)  THETA
  1      13    3.0E-05    62.4        0.3       0.3       0.
* CARD 5.2.2.3
* VWCsat  VWCres  A1      n1      A2      n2      SCFac (ft -> m)
  0.3     0.0     0.05    1.5     0.0001  7.0     0.3048
* CARD 9.4.1
* NTIMF  NTIM
  2      2
* CARD 9.4.2
* TIME   FN1      FN2
  0.0    16.      0.
  1000.  16.      0.

```

## 4-36 SMAP-W3 Example Problem

```
* CARD 9.5.1
* NWPRF   NWPR      IWPF   INTP
  1       5         0       0
* CARD 9.5.2
* WPRS    K         MW
-2000    0.3       3.0E-05
  0       0.3       3.0E-05
  10     0.3E-03   1.0E-01
  100    0.3E-03   1.0E-01
  2000   0.3E-03   1.0E-02
* CARD 10.1
* NTPRNT
  1
* CARD 10.2.1
* NHPEL
  8
* CARD 10.2.2
* NEL1
  1  2  3  4  5  6  7  8
* CARD 10.3.1
* NHPMT
  11
* CARD 10.3.2
* NODE1
  1  2  3  4  5  6  7  8  9  10  11
* CARD 10.4.1
* NTIME
  6
* CARD 10.4.2
* TIME1,  TIME2,  ...
  1.89   4.19   7.19   12.19   20.   40.
* CARD 10.5.1
* NPHD    ZEFS
  0       1.
* CARD 10.6.1
* NTHD
  0
* CARD 10.7.1
* NFLN    ISPL      DELV
  0       1         0.0
* CARD 10.8
* NFSEC   IBFQ
  0       1
* END OF DATA
```

#### 4.4 Steady-State Radial Flow Toward Well

The fourth verification problem concerns a steady-state radial water flow toward a well. An axially symmetric well shown in Figure 4.27, initially fully saturated, is subjected to drawdown of left side water table from top surface to the some level  $h_o$ . This example represents laboratory experimental test conducted by Hall (1955) for standard Ottawa sands. Saturated and unsaturated properties used for SMAP-W3 are shown in Figure 4.27.

Model parameters for unsaturated soil in Figure 4.27 are the same as those used by Taylor and Luthin (1961) where they assumed the same functions for both relative volumetric water content and relative hydraulic conductivity. Here, it simply converted to the model equations for Brutsaert (1966) and Gardner (1958).

Table 4.4 shows the listing of main input file VP4.Man. 3200 eight-node elements have been used to model this example problem. Figure 4.28 shows the key section dimensions used to generate finite element meshes. [VP4 Block Mesh 3D.pdf](#) illustrates the detailed step-by-step procedures for mesh generation. Generated finite element mesh is shown in Figure 4.29.

Following are the partial listing of graphical outputs:

Figure 4.30 Water pressure contour at steady state

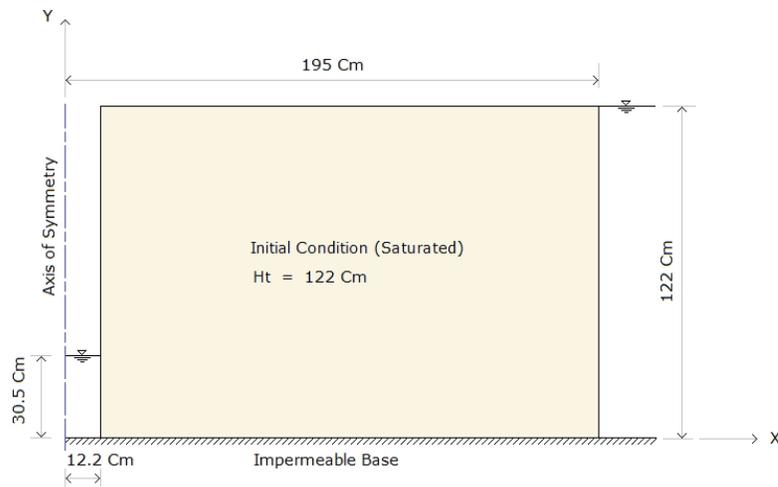
Figure 4.31 Total head contour at steady state

Figure 4.32 Darcy flow velocity at steady state

Figure 4.33 Phreatic surface at steady state

Zero water pressure contour represents the phreatic surface which is the boundary between the saturated and unsaturated zones. As shown in Figure 4.32, this phreatic surface does not represent the flow line when we consider unsaturated soil condition. Flow velocity field shows very low velocity in unsaturated zone.

Computed phreatic surfaces are compared with test result by Hall (1955) in Figure 4.33. SMAP-W3 result is close to test result at steady state. Table 4.5 shows results of computed flows compared with theoretical Dupuit-Thiem equation and Hall's test result.



Saturated Soil Properties :

$$k = 397 \text{ m/d} \quad n = 0.43$$

Unsaturated Volumetric Water Content (Brutsaert, 1966)

$$\theta_s = 0.43 \quad \theta_r = 0.0 \quad A_1 = 0.00189 \quad n_1 = 3.0$$

Unsaturated Hydraulic Conductivity (Gardner, 1958)

$$k_s = 397 \text{ m/d} \quad A_2 = 0.00189 \quad n_2 = 3.0$$

Figure 4.27 Radial flow to axially symmetric well for VP4

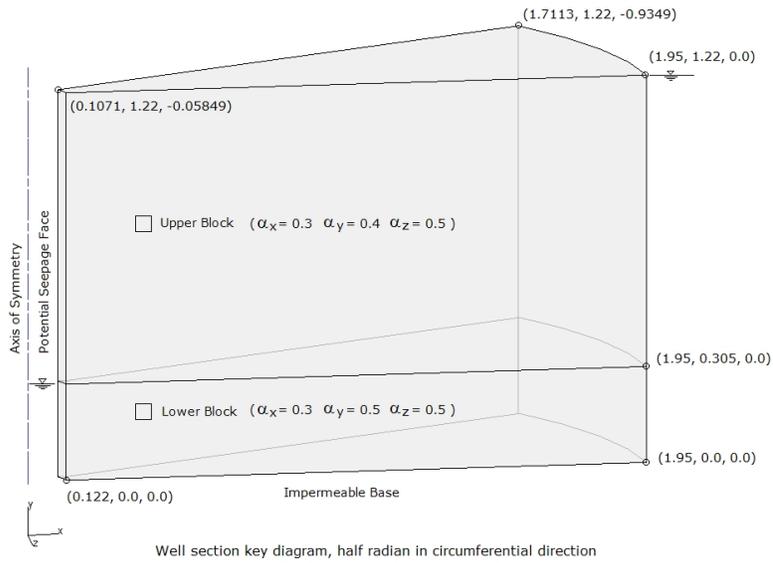
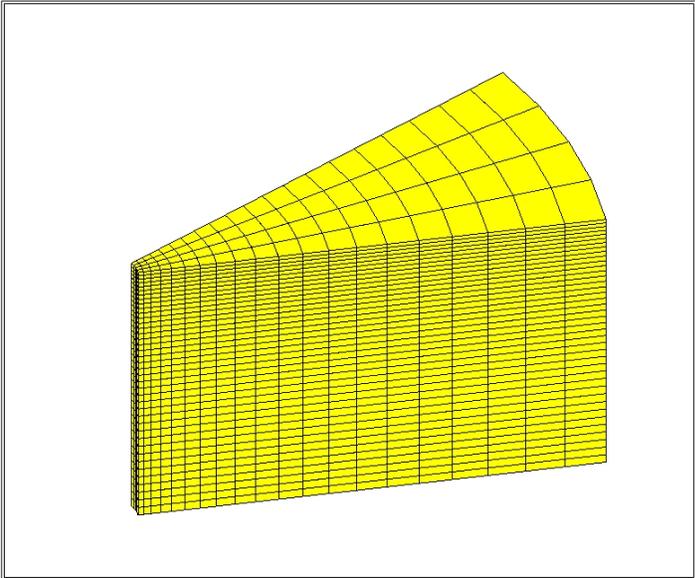


Figure 4.28 Well section key dimensions



Total Dimension  
X - direction  
Min 0.10710  
Max 1.9500  
Y - direction  
Min 0  
Max 1.2200  
Z - direction  
Min -0.93490  
Max 0



Finite Element Mesh For VP4

Figure 4.29 Finite element mesh

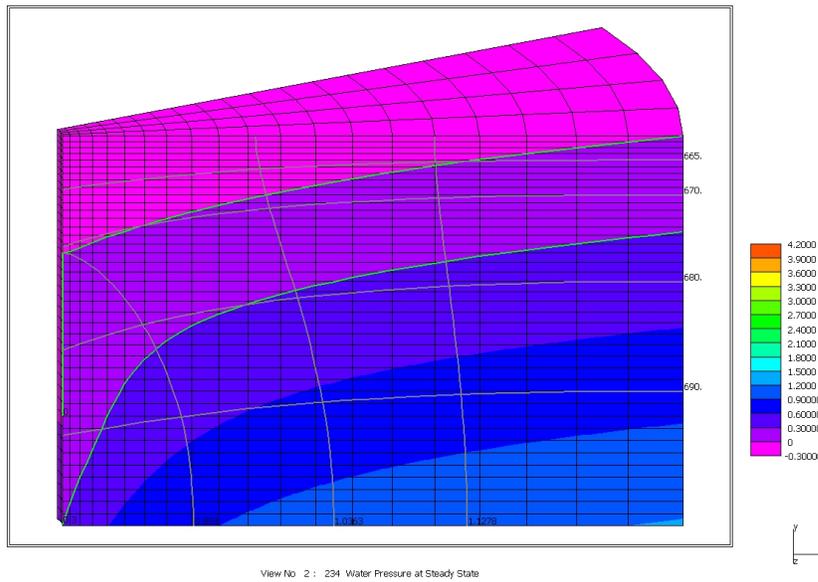


Figure 4.30 Water pressure contour at steady state

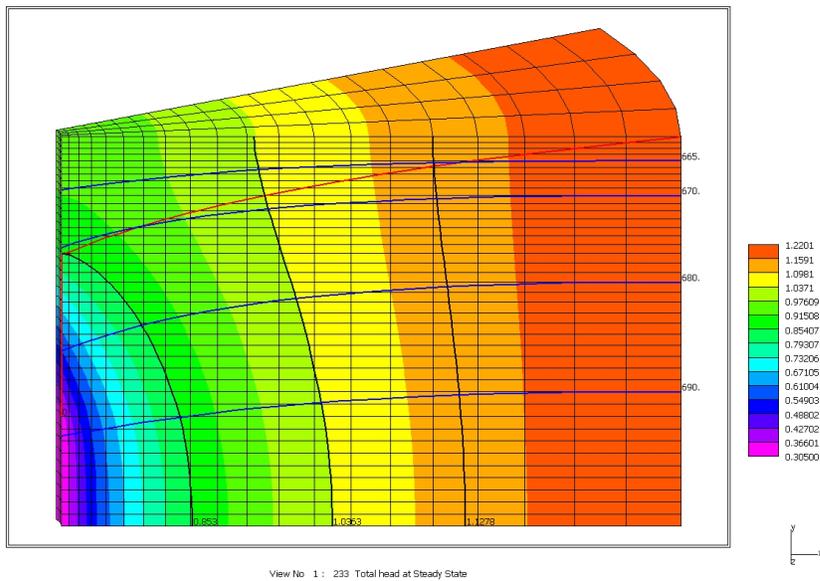


Figure 4.31 Total head contour at steady state

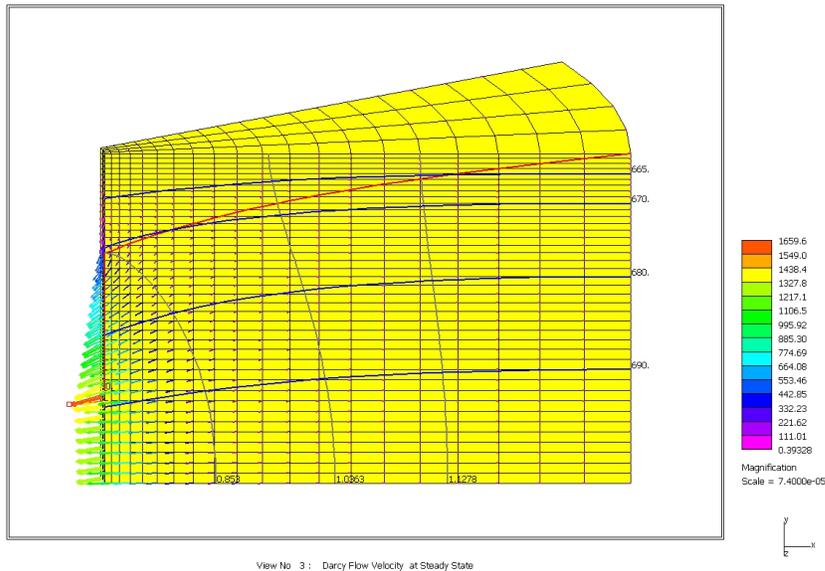


Figure 4.32 Darcy flow velocity at steady state

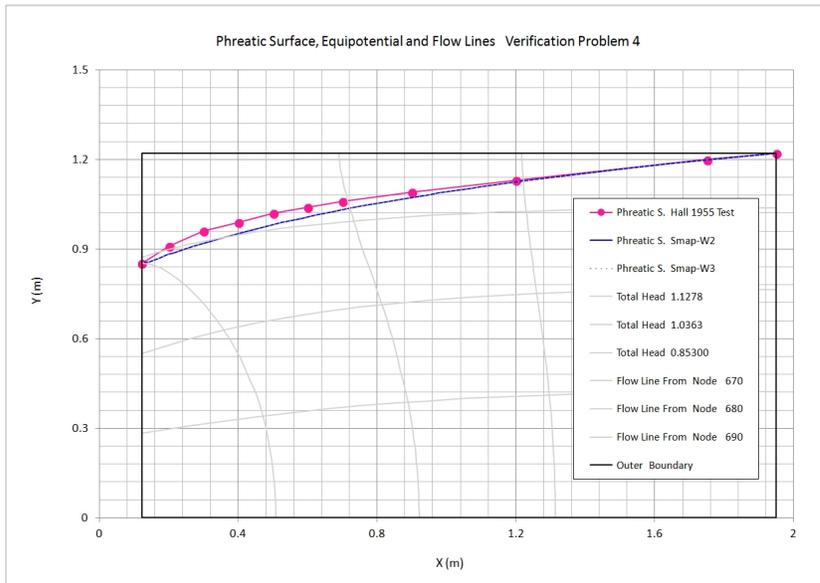


Figure 4.33 Phreatic surface at steady state

Table 4.4 Listing of main input file VP4.Man

```

* CARD 1.1
* TITLE
Verification Problem 4 (Brutsaert & Gardner)
* CARD 2.1
* IP  ILUMP  IBATCH  ISST      IMSEEP  IDFVEL  IFVOL  ISFACE
0    1      -1      1        0        0        1      1
* CARD 3.1
* NCYCL  NSTCL  NITER   MCYCL     TOLER   IRANGE  IRNODE
1000   0      20      10       0.01   0       0
* CARD 3.2
* SIP
0.5
* CARD 3.2.1
* IDELT  DT
0      0.01
* CARD 5.1
* NCONT
3200
* CARD 5.2.1
* NTNC
1
* MATFN = 13
* Gardner (1958) For Unsaturated Hydraulic Conductivity, K
* Brutsaert(1966) For Unsaturated Specific Moisture, Mw
* Model Parameters from Taylor and Luthin (1961)
* Converted to Brutsaert & Gardner
* CARD 5.2.2.1
* TITLE
MATERIAL 1
* CARD 5.2.2.2
* MATNO  MATFN  MW(m2/t)  GW(t/m3)  KH(m/d)  KV(m/d)  THETA
1        13    3.0E-05  1.0       397      397      0.
* CARD 5.2.2.3
* VWCsat  VWCres  A1      n1      A2      n2      SCFac
0.43     0.0    0.00189  3.     0.00189  3.     1.
* CARD 9.4.1
* NTIMF  NTIM
2        2
* CARD 9.4.2
* TIME   FN1     FN2
0.0     0.305   1.22
1000.   0.305   1.22
* CARD 9.5.1
* NWPRF  NWPR    IWPF    INTP
1        5      0       0

```

## 4-46 SMAP-W3 Example Problem

```
* CARD 9.5.2
* WPRS      K          MW
-2000      0.3        3.0E-05
0          0.3        3.0E-05
10         0.3E-03    1.0E-01
100        0.3E-03    1.0E-01
2000       0.3E-03    1.0E-02
* CARD 10.1
* NTPRNT
1
* CARD 10.2.1
* NHPEL
8
* CARD 10.2.2
* NEL1
1  2  3  4  5  6  7  8
* CARD 10.3.1
* NHPMT
11
* CARD 10.3.2
* NODE1
1  2  3  4  5  6  7  8  9  10  11
* CARD 10.4.1
* NTIME
2
* CARD 10.4.2
* TIME1      TIME2
1.          5.
* CARD 10.5.1
* NPHD      ZEFS
2          0.
* CARD 10.5.2
* WP1      WP1
0.0      0.3
* CARD 10.6.1
* NTHD
3
* CARD 10.6.2
* TH1      TH2      TH3
1.1278    1.0363    0.853
* CARD 10.7.1
* NFLN      ISPL      DELV
4          1          0.1
* CARD 10.7.2
* NOD1      NOD2      NOD3      NOD4
665        670        680        690
* CARD 10.8
* NFSEC      IBFQ
0          1
* END OF DATA
```

Table 4.5 Results of computed flow

Dupuit-Thiem Equation :

$$Q_{DT} = \frac{\pi \cdot k}{\ln\left(\frac{R}{r_o}\right)} (H^2 - h_o^2) = \frac{\pi \cdot (397)}{\ln\left(\frac{1.95}{0.122}\right)} (1.22^2 - 0.305^2)$$

$$Q_{DT} = 627.9 \text{ m}^3/\text{d per } 2\pi = 99.93 \text{ m}^3/\text{d per radian}$$

Hall 1955 Test A-6 Result :

$$Q_H = 345 \text{ Cm}^3/\text{s per } 15^\circ = 113.7 \text{ m}^3/\text{d per radian}$$

SMAP Result :

Analyses	Discharge Face ( r = 0.122 m )	Internal Section ( r = 0.6704 m )	Entrance Face ( r = 1.95 m )
SMAP-F2 Quad Elem.	104.75 (100.08)	104.35	104.69 (107.25)
SMAP-F2 Triangle Elem.	104.87 (98.71)	104.36	104.76 (107.41)
SMAP-W2 Quad Elem.	104.75 (100.08)	104.35	104.69 (107.25)
SMAP-W2 Triangle Elem.	104.83 (98.73)	104.38	104.78 (107.44)
SMAP-W3 Hexa Elem.	104.85 (100.06)	104.35	104.80 (107.23)
SMAP-W3 Prism Elem.	105.02 (98.69)	104.36	104.86 (107.39)

Values in ( ) are computed from global flow velocity: IBFQ = 2 in Card 10.8

### 4.5 Transient Seepage Through Generic Levee

The fifth verification problem concerns a transient seepage flow through a generic levee shown in Figure 4.34. It consists of three layers of lean clay, silty sand top stratum and pervious uniform sand aquifer. The river elevation changes with time as shown in the hydrograph in Figure 4.35. This example was solved by Tracy et al. (2016), ERDC TR-16-8 using three different computer programs; SEEP/W, SLIDE, and SEEP2D. SMAP-W3 analyses used the same model parameters as reported in the above reference.

Three different analyses are performed; homogeneous, steady-state and transient analyses. The homogeneous analysis is to check the generated mesh and boundary conditions by assuming the same hydraulic conductivity for all three layers. The steady-state analysis is conducted by applying the peak river elevation of 17.5 ft. And the transient analysis is conducted using the hydrograph in Figure 4.35.

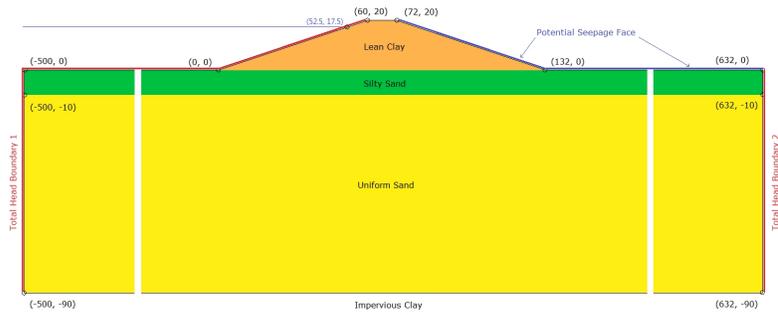
Table 4.6 shows the listing of main input file VP5.Man. This example problem is modeled by 5512 three-dimensional elements mixed with hexa and some prism along the levee slopes. [VP5 Group Mesh.pdf](#) illustrates the detailed step-by-step procedures for mesh generation. Generated finite element mesh around levee is shown in Figure 4.36.

Following are the partial listing of graphical outputs:

- Figure 4.37 Homogeneous result with phreatic and other surfaces
- Figure 4.38 Steady-state result with phreatic and other surfaces
- Figure 4.39 Transient phreatic surface at 14 days
- Figure 4.40 Total head variation at 10 feet below toe
- Figure 4.41 Flow rate through landside ground surface

Overall, SMAP-W3 results are very close to those results in the above reference (ERDC TR-16-8) except flow rate variation in Figure 4.41. At 20 days, SMAP-W3 shows about 15 percent lower peak flow rate compared to ERDC result.

[VP5 Result Summary.pdf](#) includes more detailed transient results at key locations compared with the ERDC report.



Unsaturated soils modeled by van Genuchten (1980)

Material Type	$k_s$ [ft/d]	$M_w$ [ft <sup>3</sup> /lb]	$\theta_s$	$\theta_r$	$a$ [ft <sup>2</sup> /lb]	$n$
Lean Clay	0.0028	$10^{-5}$	0.5	0.05	0.004885	1.23
Silty Sand	0.28	$10^{-5}$	0.35	0.035	0.04975	2.24
Uniform Sand	28	$10^{-5}$	-	-	-	-

Figure 4.34 Generic levee section for VP5

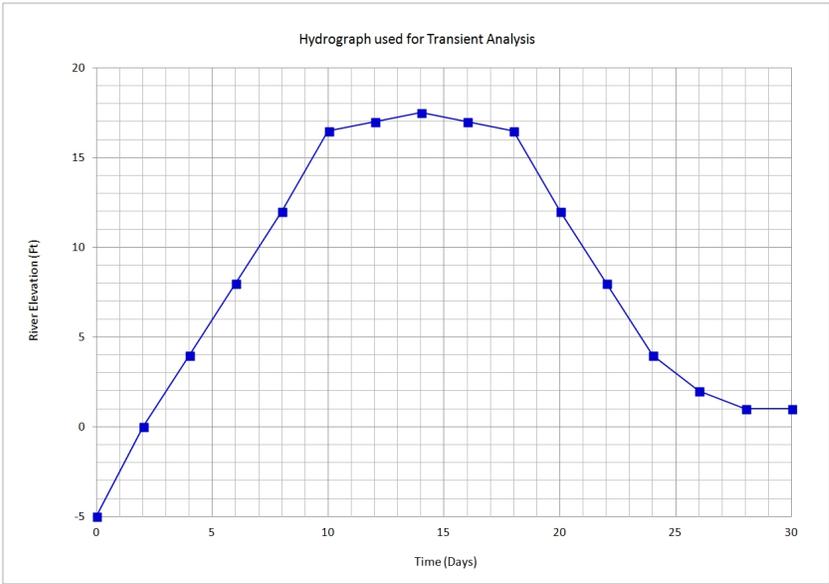


Figure 4.35 Hydrograph used for transient analysis

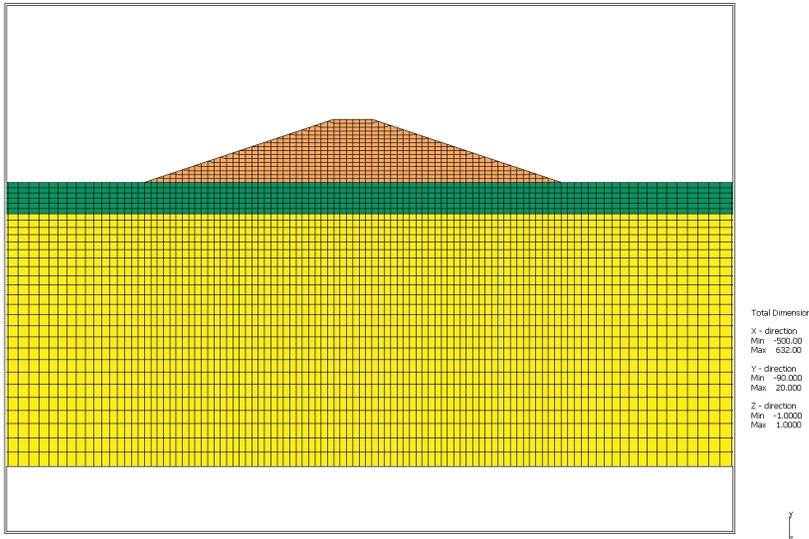


Figure 4.36 Finite element mesh around levee

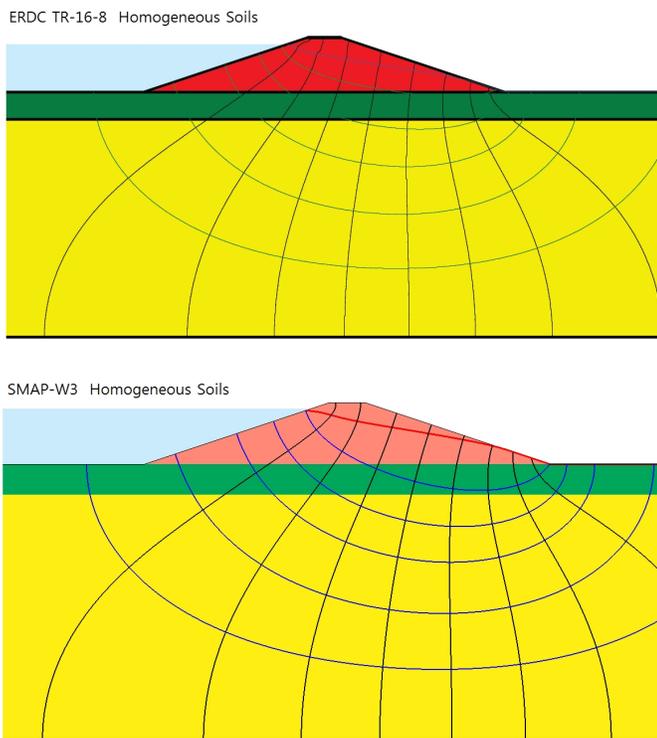


Figure 4.37 Homogeneous result with phreatic and other surfaces

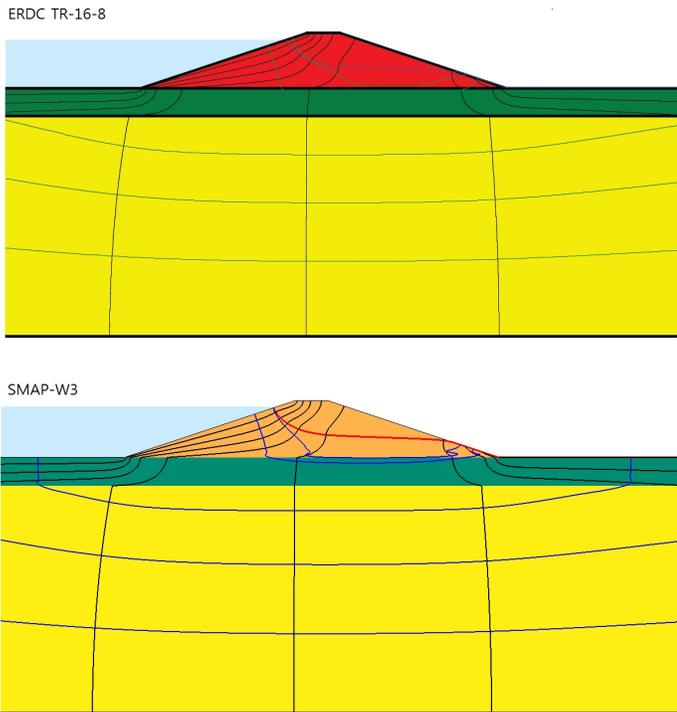


Figure 4.38 Steady-state result with phreatic and other surfaces

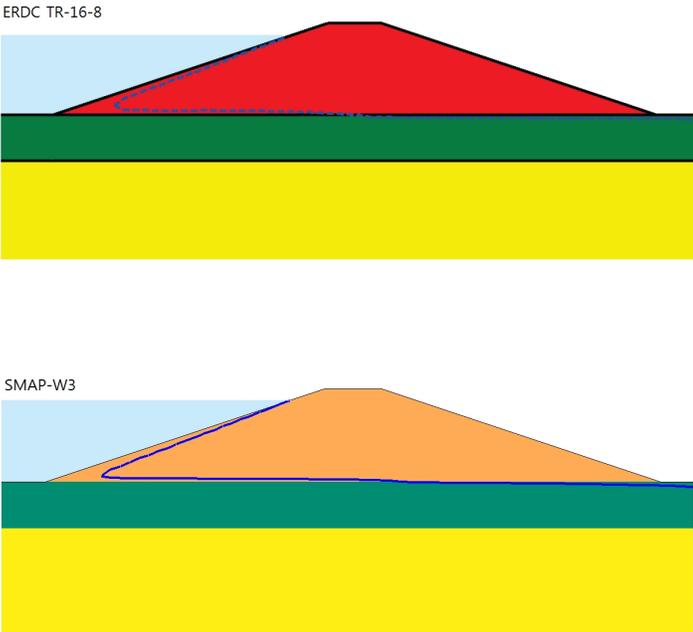


Figure 4.39 Transient result with phreatic surface at 14 days

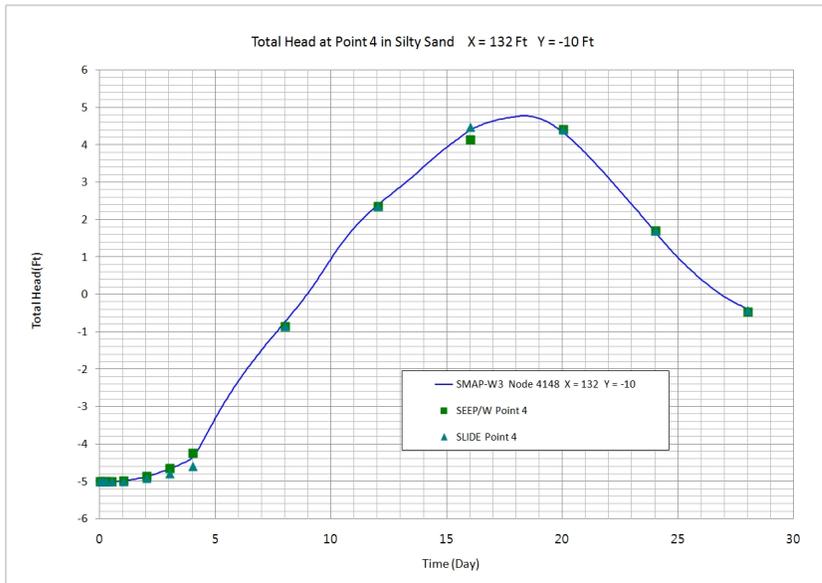


Figure 4.40 Total head variation at 10 feet below toe

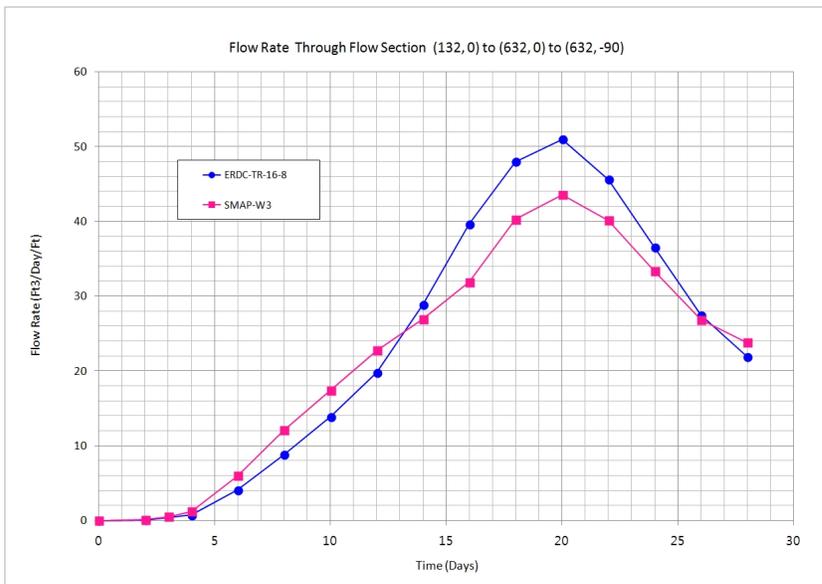


Figure 4.41 Flow rate through landside ground surface

Table 4.6 Listing of main input file VP5.Man

```

* CARD 1.1
* TITLE
  Verification Problem 5 (ERDC TR-16-8 GENERIC LEVEE)
* CARD 2.1
* IP  ILUMP  IBATCH  ISST  IMSEEP  IDFVEL  IFVOL  ISFACE
  1   1      -1      1     0        0       1      1
* CARD 3.1
* NCYCL  NSTCL  NITER  MCYCL  TOLER  IRANGE  IRNODE
  280    0      20     10     0.01    0       0
* CARD 3.2
* SIP
  0.5
* CARD 3.2.1
* IDELT  DT
  0      0.1
* CARD 5.1
* NCONT
  5512
* CARD 5.2.1
* NTNC
  3
* CARD 5.2.2.1
* TITLE
  MATERIAL 1 (Lean Clay)
* CARD 5.2.2.2
* MATNO MATFN MW(ft2/lb) GW(lb/ft3) KH(ft/d) KV(ft/d) THETA
  1      11    1.0E-05  62.4      0.0028  0.0028  0.
* CARD 5.2.2.3
* VWCsat VWCres alpha(ft2/lb) n      m      Uswcc SCFac Gwm Pr
  0.5    0.05  0.004885      1.23 0.187 0      1.    62.4 0.
* CARD 5.2.2.1
* TITLE
  MATERIAL 2 (Silty Sand)
* CARD 5.2.2.2
* MATNO MATFN MW(ft2/lb) GW(lb/ft3) KH(ft/d) KV(ft/d) THETA
  2      11    1.0E-05  62.4      0.28    0.28    0.
* CARD 5.2.2.3
* VWCsat VWCres alpha(ft2/lb) n      m      Uswcc SCFac Gwm Pr
  0.35   0.035 0.04975      2.24 0.5536 0      1.    62.4 0.
* CARD 5.2.2.1
* TITLE
  MATERIAL 3 (Uniform Sand)

```

## 4-58 SMAP-W3 Example Problem

```
* CARD 5.2.2.2
* MATNO MATFN MW(ft2/lb) GW(lb/ft3) KH(ft/d) KV(ft/d) THETA
3      0      1.0E-05      62.4      28      28      0.
* CARD 9.4.1
* NTIMF      NTIM
2          16
* CARD 9.4.2
* TIME      FN1      FN2
0.         -5.      -5.
2.         0.       -5.
4.         4.       -5.
6.         8.       -5.
8.        12.      -5.
10.       16.5     -5.
12.       17.     -5.
14.       17.5     -5.
16.       17.     -5.
18.       16.5     -5.
20.       12.     -5.
22.        8.     -5.
24.        4.     -5.
26.        2.     -5.
28.        1.     -5.
300.       1.     -5.
* CARD 9.5.1
* NWPRF      NWPR      IWPFF      INTP
0          0          0          0
* CARD 10.1
* NTPRNT
1
* CARD 10.2.1
* NHPEL
8
* CARD 10.2.2
* NEL1
1  2  3  4  5  6  7  8
* CARD 10.3.1
* NHPMT
6
* CARD 10.3.2
* NODE1      NODE2      NODE3      NODE4      NODE5      NODE6
3020      3389      3539      3701      3818      4148
* CARD 10.4.1
* NTIME
11
* CARD 10.4.2
* TIME1      TIME2      TIME3      TIME4      TIME5      TIME6      TIME7
6.         10.        12.        14.        16.        18.        20.
22.        24.        26.        28.
```

```

* CARD 10.5.1
* NPHD   ZEFS
  4     0.
* CARD 10.5.2
* WP1    WP2    WP3    WP4
  0.0   1000.  2000.  3000.
* CARD 10.6.1
* NTHD
  9
* CARD 10.6.2
* TH1    TH2    TH3    TH4    TH5    TH6    TH7    TH8    TH9
  0     2     4     6     8     10    12    14    16
* CARD 10.7.1
* NFLN   ISPL   DELV
  3     1     0.0
* CARD 10.7.2
* NOD1   NOD2   NOD3   NOD4   NOD5
  63    466    1148   2369   2500
* CARD 10.8
* NFSEC  IBFQ
  1     0
* CARD 10.8.1
* NODES: Flux Section (132, 0) to (632, 0) to (632, -90)
  81
* LIST OF NODES
* Potential Seepage Face (Ground)
4142  4173  4204  4235  4266  4297  4328  4359  4390  4421
4452  4483  4514  4545  4576  4607  4638  4669  4700  4731
4762  4793  4824  4855  4886  4917  4948  4979  5010  5041
5072  5103  5134  5165  5196  5227  5258  5289  5320  5351
5382  5413  5444  5475  5506  5537  5568  5599  5630  5661
9833  9864  9895  9926  9957  9988  10019 10050 10081 10112
10143 10174 10205 10236 10267 10298 10329 10360 10391 10422
10453 10484 10515 10546 10577 10608 10639 10670 10701 10732
10763 10794 10825 10856 10887 10918 10949 10980 11011 11042
11073 11104 11135 11166 11197 11228 11259 11290 11321 11352
* Total Head Boundary 2
      5662  5663  5664  5665  5666  5667  5668  5669  5670
5671  5672  5673  5674  5675  5676  5677  5678  5679  5680
5681  5682  5683  5684  5685  5686  5687  5688  5689  5690
5691  11352 11353 11354 11355 11356 11357 11358 11359 11360
11361 11362 11363 11364 11365 11366 11367 11368 11369 11370
11371 11372 11373 11374 11375 11376 11377 11378 11379 11380
11381 11382
* END OF DATA

```

## 4.6 Steady-State Seepage Through Earth Dam

The sixth verification problem concerns a steady-state seepage flow through a homogeneous isotropic earth dam shown in Figure 4.42. Figure 4.43 shows unsaturated hydraulic conductivity as a function of suction to model the unsaturated part of dam above the phreatic surface. This example is the same as the Example 9-5 in Physical and Geotechnical Properties of Soils by Bowles (1984) and also solved using two different computer programs; SEEP/W and SLIDE. SMAP-W3 analyses used the same model parameters as reported in the above reference.

Three different finite element meshes are prepared as shown in Figure 4.44. Mesh 1 is generated by the Group Mesh Generator. Refer to [VP6 Group Mesh.pdf](#). Mesh 2 and 3 are generated by the Earth Dam Mesh Generator which is the special feature in Addrgn-2D. Refer to [VP6 Earth Dam Mesh.pdf](#). Note that these two dimensional meshes are extended by program [GEN-3D](#) and then boundary conditions are specified by program [LOAD-3D](#).

Table 4.7 shows the listing of main input file VP6.Man for Mesh 1. The other input files for Mesh 2 and 3 are similar to Mesh 1 input.

Figure 4.45 shows computed results of selected flow lines and total head contours along with the phreatic surface in red line. All three analyses with different finite element meshes show almost the same total head contours. Note that the flow path starting at the water elevation of upstream slope is slightly above the the phreatic surface for most part. This means that there are some water flow in unsaturated zone above the phreatic surface.

Table 4.8 shows steady-state flow rate on downstream seepage face. Overall, SMAP-W3 results are very close to those published results. SMAP-W3 results are not sensitive to the number of elements. They all show flow rate of about  $1.39 \times 10^{-3} \text{ m}^3/(\text{min. m})$ .

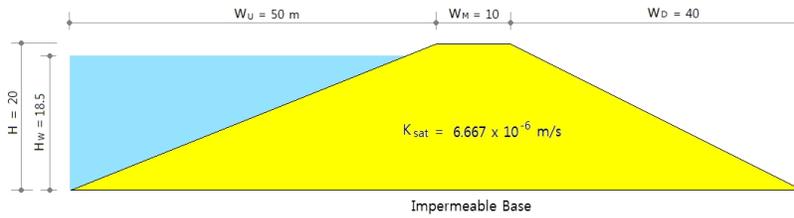


Figure 4.42 Earth dam cross section for VP6

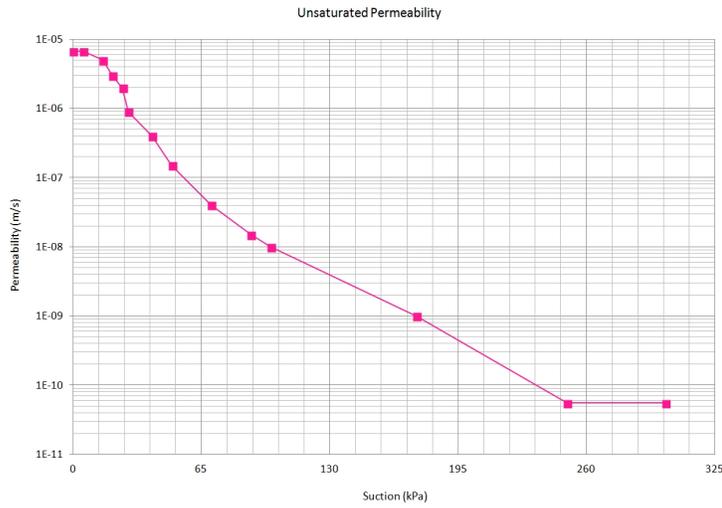
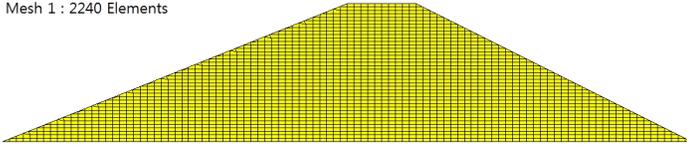
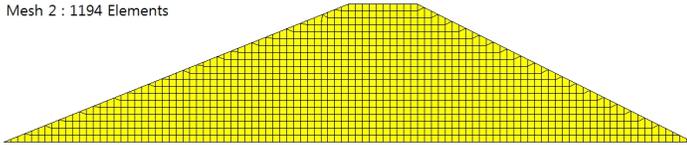


Figure 4.43 Unsaturated hydraulic conductivity

Mesh 1 : 2240 Elements



Mesh 2 : 1194 Elements



Mesh 3 : 561 Elements

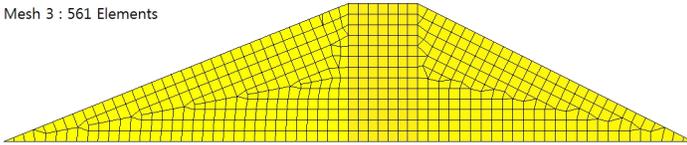


Figure 4.44 Finite element meshes

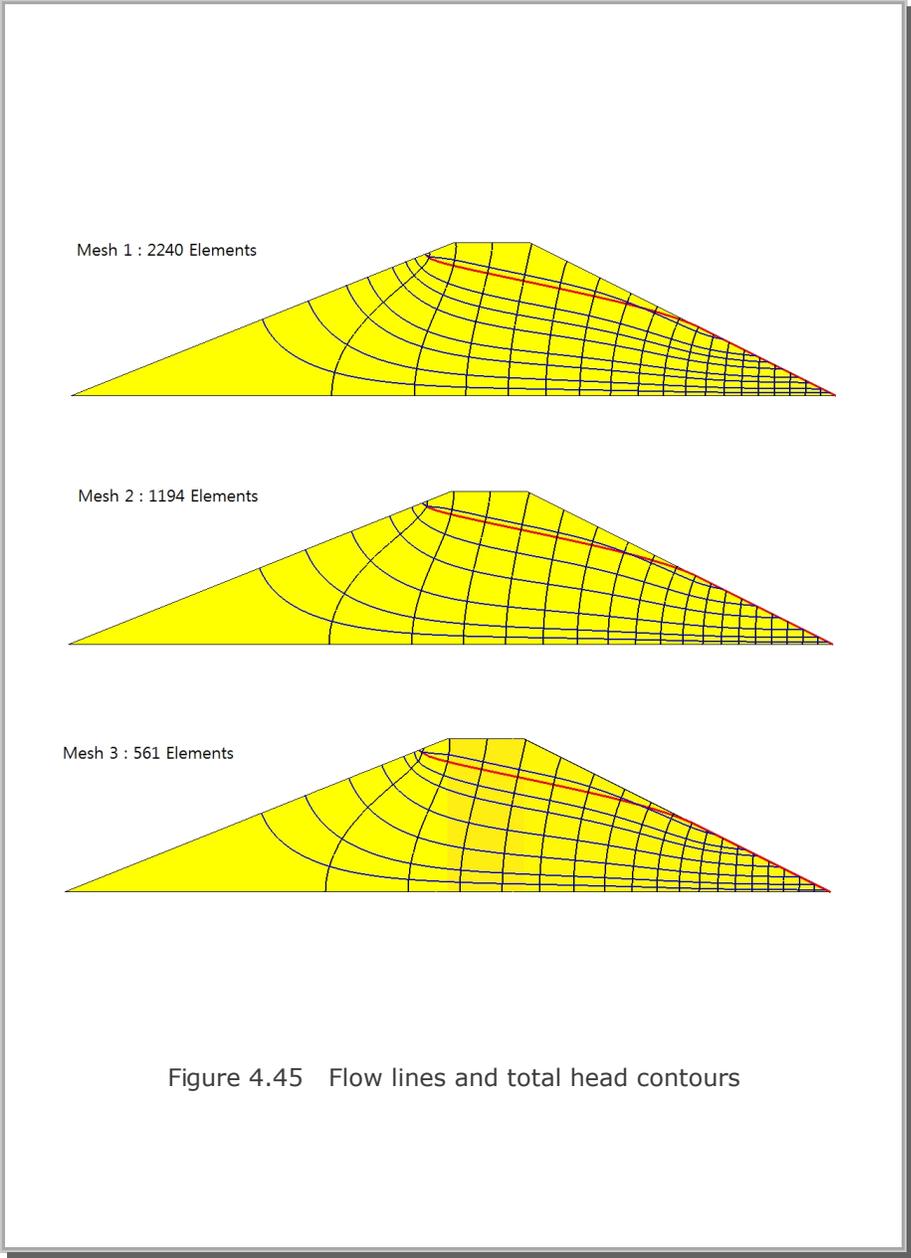


Table 4.7 Listing of main input file VP6.Man

```

* CARD 1.1
* TITLE
Verification Problem 6 (Mesh 1)
* CARD 2.1
* IP  ILUMP  IBATCH  ISST  IMSEEP  IDFVEL  IFVOL  ISFACE
1    1      -1      0      0      1      1      1
* CARD 3.1
* NCYCL  NSTCL  NITER  MCYCL  TOLER  IRANGE  IRNODE
100    1      20     10     0.01  0      0
* CARD 3.2
* SIP
0.5
* CARD 3.2.1
* IDELT  DT
0      0.1
* CARD 5.1
* NCONT
2240
* CARD 5.2.1
* NTNC
1
* CARD 5.2.2.1
* TITLE
MATERIAL 1
* CARD 5.2.2.2
* MATNO  MATFN  MW(1/kPa)  GW(kN/m3)  KH(m/s)  KV(m/s)  THETA
1      1      1.0E-05  9.81  6.67e-6  6.67e-6  0.
* CARD 5.2.2.3
* VWCsat  VWCres  alpha(1/m)  n  m  Uswcc  SCFac  Gwm  Pr
0.45  0.15  0.1  0  0  0  1.  9.81  0.
* CARD 9.4.1
* NTIMF  NTIM
1      2
* CARD 9.4.2
* TIME  FN1
0.      18.5
10000.  18.5

```

```

* CARD 9.5.1
* NWPRF   NWPR      IWPF   INTP
  1       15        0       1
* CARD 9.5.2
* WP (kPa)  K(m/s)      Mw(1/kPa)
-1000.    6.67E-6      1.0E-5
  0.      6.67E-6      1.0E-5
  5.      6.67E-6      1.0E-5
 15.      5.00E-6      1.0E-5
 20.      3.00E-6      1.0E-5
 25.      2.00E-6      1.0E-5
 28.      9.00E-7      1.0E-5
 40.      4.00E-7      1.0E-5
 50.      1.50E-7      1.0E-5
 70.      4.00E-8      1.0E-5
 90.      1.50E-8      1.0E-5
100.      1.00E-8      1.0E-5
174.      1.00E-9      1.0E-5
250.      5.50E-11     1.0E-5
1000.     5.50E-11     1.0E-5
* CARD 10.1
* NTPRNT
  1
* CARD 10.2.1
* NHPEL
  8
* CARD 10.2.2
* NEL1
  1  2  3  4  5  6  7  8
* CARD 10.3.1
* NHPMT
 11
* CARD 10.3.2
* NODE1
  1  2  3  4  5  6  7  8  9 10 11
* CARD 10.4.1
* NTIME
  3
* CARD 10.4.2
* TIME1   TIME2   TIME3
  0.1     1       10
* CARD 10.5.1
* NPHD    ZEFS
  4       0.
* CARD 10.5.2
* WP1     WP2      WP3      WP4
  0       50      100      150

```

## 4-66 SMAP-W3 Example Problem

```
* CARD 10.6.1
* NTHD
18
* CARD 10.6.2
* TH1      TH2      TH3      TH4      TH5
1          2          3          4          5
6          7          8          9          10
11         12         13         14         15
16         17         18
* CARD 10.7.1
* NFLN     ISPL     DELV
8          1          0.0
* CARD 10.7.2
* NOD1     NOD2     NOD3     NOD4     NOD5
266       404       541       633       732
802       838       875
* CARD 10.8
* NFSEC    IBFQ
1          0
* Flux Section (Landside Seepage Surface)
* CARD 10.8.1
* NODES
82
* Potential Seepage Face (Ground), Generated by Group Mesh
* LIST OF NODES
1441 1482 1522 1561 1599 1636 1672 1707 1741 1774
1806 1837 1867 1896 1924 1951 1977 2002 2026 2049
2071 2092 2112 2131 2149 2166 2182 2197 2211 2224
2236 2247 2257 2266 2274 2281 2287 2292 2296 2299
2301 3742 3783 3823 3862 3900 3937 3973 4008 4042
4075 4107 4138 4168 4197 4225 4252 4278 4303 4327
4350 4372 4393 4413 4432 4450 4467 4483 4498 4512
4525 4537 4548 4558 4567 4575 4582 4588 4593 4597
4600 4602
* END OF DATA
```

Table 4.8 Steady-state flow rate on seepage face

Program	Total Elements	Flow Rate m <sup>3</sup> /(min. m)	Reference
Bowles	Flow nets	1.103 x 10 <sup>-3</sup>	Bowles, 1984 (Example 9.5a)
	Equation	1.280 x 10 <sup>-3</sup>	Direct computation with Eq. 9.4
RS2	391	1.378 x 10 <sup>-3</sup>	SLIDE verification manual, 2022
SEEP / W	295	1.410 x 10 <sup>-3</sup>	Chapuis R, et al. 2001
	1145	1.370 x 10 <sup>-3</sup>	Chapuis R, et al. 2001
SMAP-W3	2240	1.3897 x 10 <sup>-3</sup>	Mesh 1
	1194	1.3906 x 10 <sup>-3</sup>	Mesh 2
	561	1.3893 x 10 <sup>-3</sup>	Mesh 3



## **Group Mesh Example Problem**

[Group Mesh Generator](#) is a two-dimensional CAD program specially designed to build group mesh which can be used to generate finite element mesh with the aid of program [ADDRGN-2D](#). [Group Mesh User's Manual](#) describes all the basic functions associated with group mesh generation and modifications.

Two example problems are presented:

1. [Arch Tunnel](#)  
Shows step-by-step procedure to create and modify group meshes.
2. [Finite Element Mesh Modification](#)  
Illustrates how to modify existing finite element meshes using [Mesh Generator](#).

## **5.1 Arch Tunnel**

The main objective of this first example is to show the step-by-step procedure to create and modify group meshes.

This example has the following three parts:

### **Part 1 : Creating Arch Tunnel (Figure 5.1)**

- Create group mesh
- Set built-in base mesh
- Draw arch tunnel
- Plot finite element mesh

### **Part 2 : Adding Rock Bolts (Figure 5.2)**

- Open the group mesh file in part 1
- Add three rock bolts
- Plot finite element mesh

### **Part 3 : Adding Utility Tunnel (Figure 5.3)**

- Open the group mesh file in part 2
- Remove the first rock bolt
- Change the second rock bolt length
- Replace the third rock bolt by utility tunnel
- Plot finite element mesh

Table 5.1 shows the construction sequence.

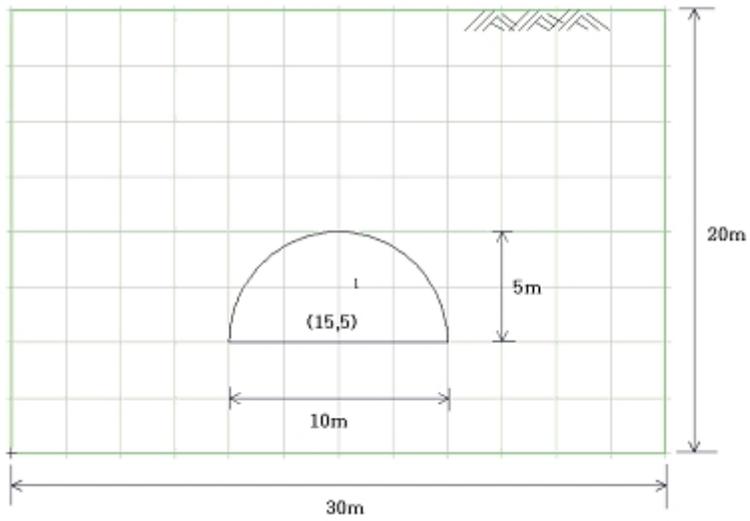


Figure 5.1 Arch tunnel (Part 1)

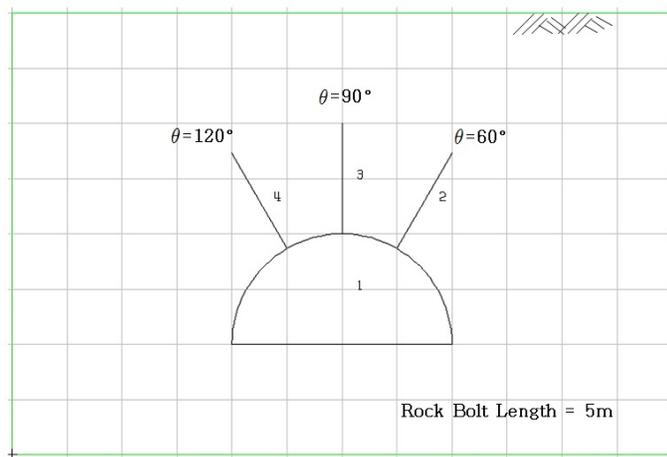


Figure 5.2 Arch tunnel with rock bolts (Part 2)

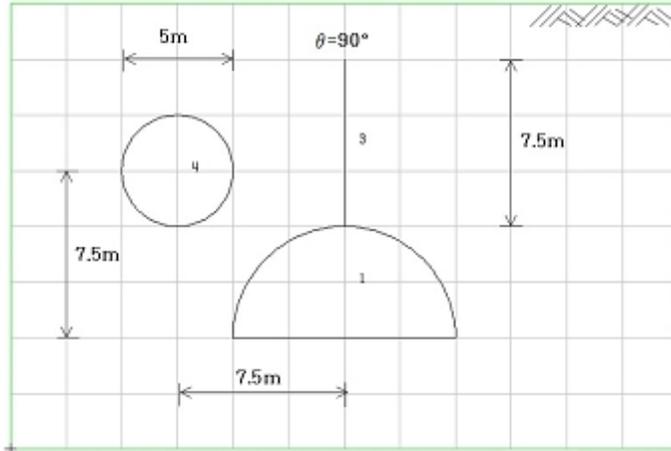


Figure 5.3 Arch tunnel with utility tunnel (Part 3)

Step No	Description
1, 2	In-Situ Stress
3	Arch Tunnel Excavation & Lining Installation
4	Rock Bolt Installation
5	Utility Tunnel Construction

Table 5.1 Construction sequence

### 5.1.1 Part 1: Creating Arch Tunnel

Part 1 consists of the following main actions:

- Create group mesh
- Set built-in base mesh
- Draw arch tunnel
- Plot finite element mesh

#### Step 1: Group Mesh Generator (New)

Access **Group Mesh Generator** by selecting the following menu items in **SMAP** (Figure 5.4):

Run → Mesh Generator → Group Mesh → New

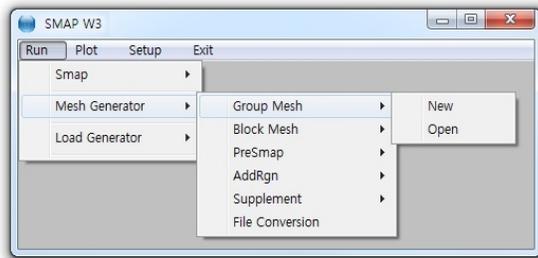


Figure 5.4 Accessing group mesh generator (New)

#### Step 2: Group Input (New)

Select **Built-in Base Mesh** in Figure 5.5. Click **OK**.

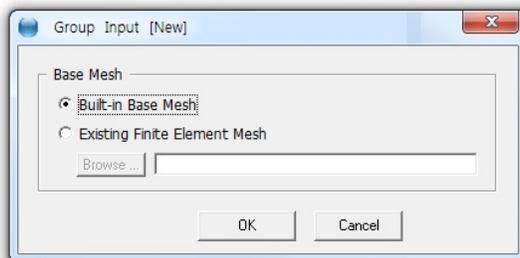


Figure 5.5 Group input (New)

### Step 3: Group Menu and Dialog

Click **Group** menu in **PLOT-2D** as shown in Figure 5.6.



Figure 5.6 Group menu

**Group** dialog in Figure 5.7 is displayed with initial default values.

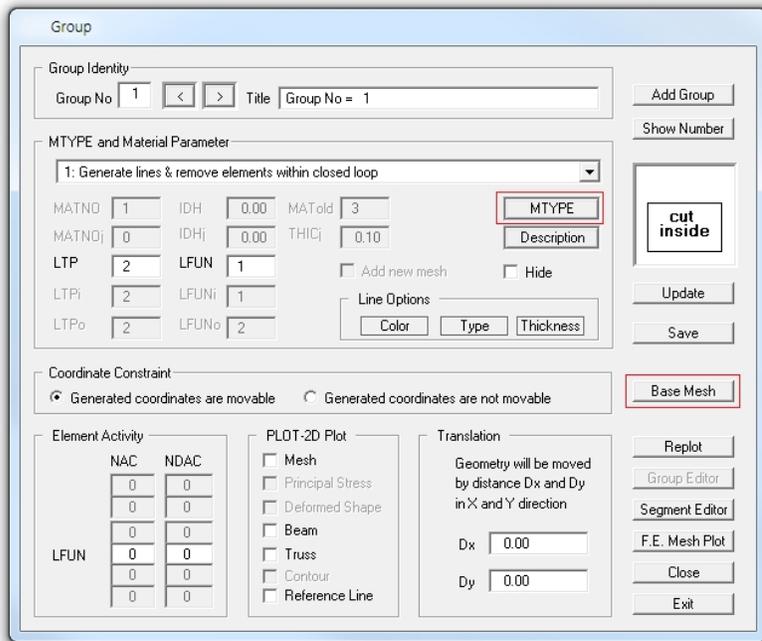


Figure 5.7 Group dialog with initial default values

### Step 4: Built-in Base Mesh

Click **Base Mesh** button in **Group** dialog.

Fill in input fields for **Built-in Base Mesh** as shown in Figure 5.8. Click **OK**.

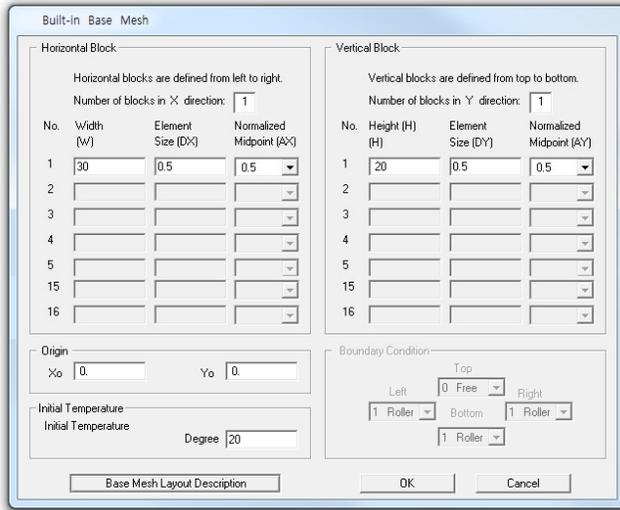


Figure 5.8 Built-in base mesh dialog

Figure 5.9 shows Base Mesh with dimensions of 30m x 20m on drawing board in **PLOT-2D**.

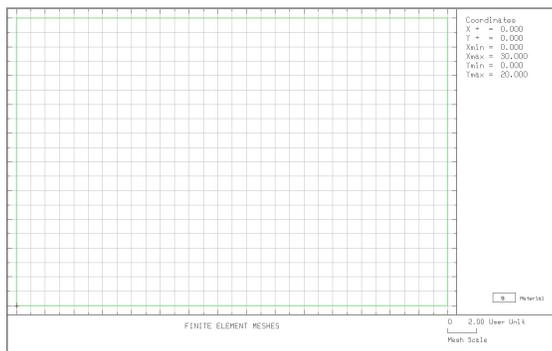


Figure 5.9 Base mesh on drawing board

**Step 5: MTYPE**

Click **MTYPE** button in **Group** dialog.  
 Select **MTYPE=3** in **MTYPE** dialog in Figure 5.10.  
 Click **OK**.

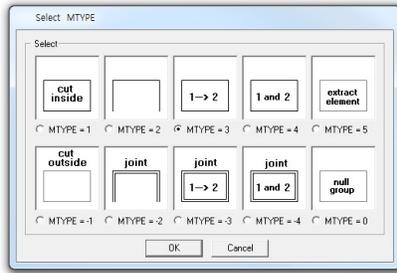


Figure 5.10 MTYPE dialog

Fill in input fields for **Group** dialog as shown in Figure 5.11.

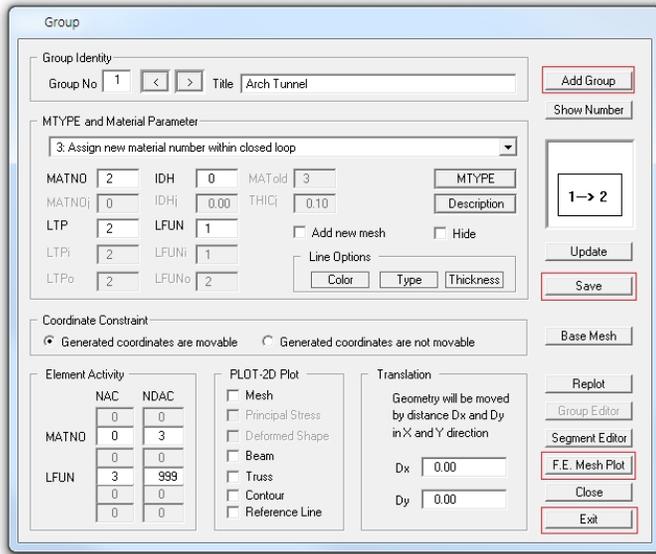
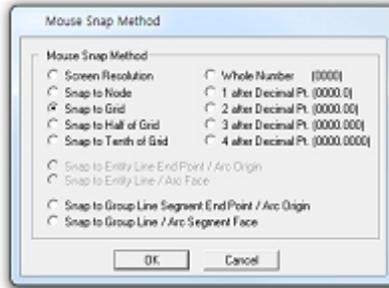


Figure 5.11 Group dialog with MTYPE = 3

**Step 6: Mouse Snap**

Click **Mouse-Snap** menu in **PLOT-2D**.  
 Select **Snap to Grid** in Figure 5.12. Click **OK**.

Figure 5.12  
 Mouse snap dialog



**Step 7: Add Group**

Click **Add Group** button in **Group** dialog.

Table 5.2 summarizes group parameters used for arch tunnel.

Group No	MTYPE	Description	Element Type	Mat. Np.	Element Activity	
					NAC	NDAC
1	3	Core	Cont.	MATNO=2	0	3
		Lining	Beam (LPT=2)	LFUN=1	3	999

Group No	Seg. No	Line Segment				Arc Segment						IEND
		Beginning Point		Ending Point		Origin		Radius and Angle				
		X	Y	X	Y	X <sub>o</sub>	Y <sub>o</sub>	R <sub>x</sub>	R <sub>y</sub>	θ <sub>b</sub>	θ <sub>e</sub>	
1	1	10	5	20	5							2
	2					15	5	5	5	0	180	2

Table 5.2 Group parameters for arch tunnel

### Step 8: Line Segment

Click **Draw** button in **Line Segment** dialog in Figure 5.13.



Figure 5.13 Line segment dialog

Click the mouse where the line begins and then click the mouse where the line ends as shown in Figure 5.14.



Figure 5.14 Line segment on drawing board

### Step 9: Arc Segment

Click **Arc Segment** button in **Line Segment** dialog.

Fill in input fields for **Arc Segment** as shown in Figure 5.15.

Click **Draw**.

Figure 5.15 Arc segment dialog

Press down and hold mouse button on the drawing board.

Drag the mouse to the location of arc origin and then release the mouse button as shown in Figure 5.16.

Click **Finish**.

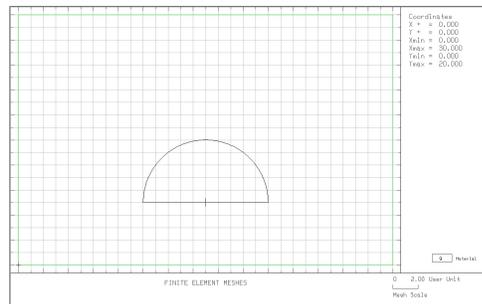


Figure 5.16 Arc segment on drawing board

**Step 10: Save**

Click **Save** button in **Group** dialog.  
**Group.Meg** is saved as shown in Figure 5.17.

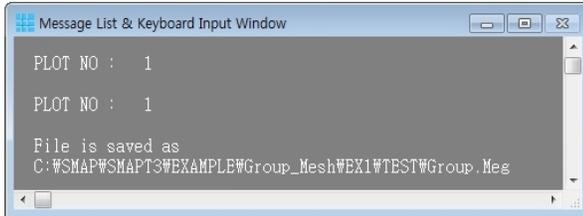


Figure 5.17 Message for file save

**Step 11: Finite Element Mesh**

Click **F.E. Mesh Plot** button in **Group** dialog.  
Click **Yes** in Figure 5.18.

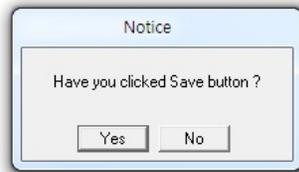


Figure 5.18 Notice for finite element mesh plot

**Please Wait...** message in Figure 5.19 is shown on the screen while generating finite element mesh plot.

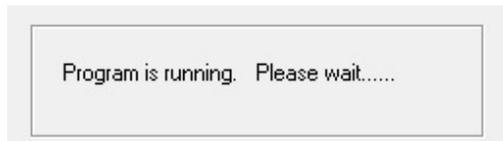


Figure 5.19 Notice while generating finite element mesh plot

Once finished, finite element mesh file is generated as **Group.Mes** in the sub directory **Plot\_Mesh** as shown in Figure 5.20 along with finite element mesh plot in Figure 5.21.

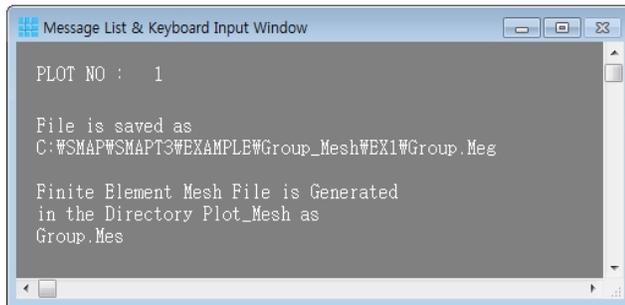


Figure 5.20 Message for finite element mesh file

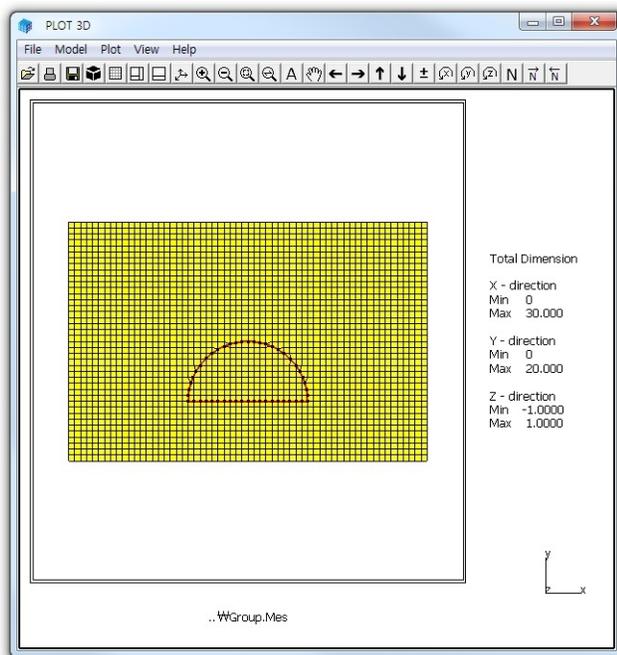


Figure 5.21 Finite element mesh plot

**Step 12: Exit**

Click **Exit** button in **Group** dialog.

Click **OK** in **Exit** dialog as shown in Figure 5.22.

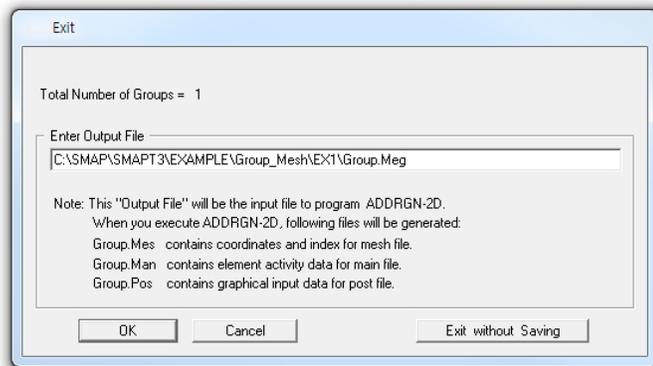


Figure 5.22 Exit dialog

### 5.1.2 Part 2: Adding Rock Bolts

Part 2 consists of the following main actions:

- Open the group mesh file in part 1
- Add three rock bolts
- Plot finite element mesh

#### Step 13: Group Mesh Generator (Open)

Access [Group Mesh Generator](#) by selecting the following menu items in [SMAP](#) (Figure 5.4):

Run → Mesh Generator → Group Mesh → Open

#### Step 14: Group Input (Open)

File open dialog will be displayed as in Figure 5.23.

Select group mesh file [Group.Meg](#) in Part 1 and click [Open](#).



Figure 5.23 File open dialog

#### Step 15: Group Menu and Dialog

Click [Group](#) menu in [PLOT-2D](#) as shown in Figure 5.6.

[Group](#) dialog for Group No 2 is displayed with initial default values.

#### Step 16: MTYPE

Click [MTYPE](#) button in [Group](#) dialog.

Select [MTYPE=2](#) in [MTYPE](#) dialog in Figure 5.10.

Click [OK](#).

**Step 17: Group No 2 for Rock Bolt 1**

Table 5.3 summarizes group parameters for rock bolts. Rock bolt is modeled by a straight radial line in Arc Segment.

Group No	Bolt No	MTYPE	Elem. Type (LTP)	Mat. No (LFUN)	Element Activity		Radius and Angle				IEND
					NAC	NDAC	R <sub>x</sub>	R <sub>y</sub>	Θ <sub>b</sub>	Θ <sub>e</sub>	
2	Bolt-1	2	Truss (3)	1	4	999	5	10	60	60	-2
3	Bolt-2	2	Truss (3)	1	4	999	5	10	90	90	-2
4	Bolt-3	2	Truss (3)	1	4	999	5	10	120	120	-2

Table 5.3 Group parameters for rock bolts

Group No 2 represents Rock Bolt 1 with a length of 5m at 60 degrees. Fill in input fields for Group dialog as shown in Figure 5.24.

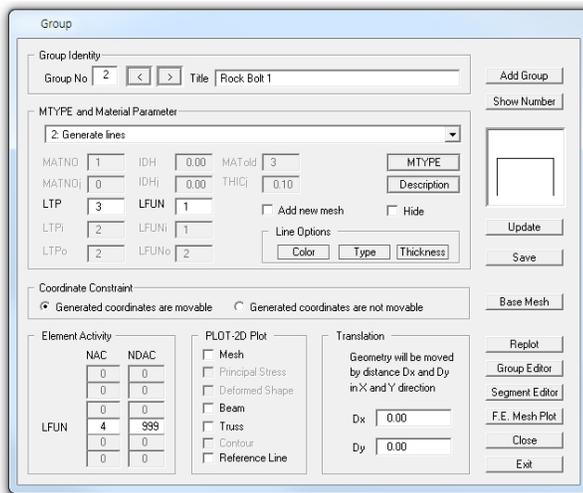


Figure 5.24 Group dialog for Rock Bolt 1

**Step 18: Mouse Snap**

Click **Mouse-Snap** menu in **PLOT-2D**.  
Select **Snap to Grid** in Figure 5.12.  
Click **OK**.

**Step 19: Add Group**

Click **Add Group** button in **Group** dialog.

**Step 20: Arc Segment**

Click **Arc Segment** button in **Line Segment** dialog.  
Fill in input fields for **Arc Segment** as shown in Figure 5.25.  
Click **Draw**.

Arc Segment

Segment No = 1  
Group No: 2 Rock Bolt 1

Origin By:  Mouse Pickup  Enter X and Y

Enter Origin: Xo  Yo

Enter Radius and Angle:

Horizontal Radius : Rx   
Vertical Radius : Ry   
Beginning Angle (Deg.): Qb   
Ending Angle (Deg.): Qe

Note: When Qb = Qe, a straight radial line is drawn from R = Rx to R = Ry.  
That is, Rx and Ry represent radial distances at angle Q = Qb = Qe.

Divisions and Inclusions:

Divisions:  Inclusions:

Draw Line Segment Finish Cancel

Figure 5.25 Arc segment dialog for Rock Bolt 1

Press down and hold mouse button on the drawing board.  
Drag the mouse to the location of arc origin and then release  
the mouse button as shown in Figure 5.26. Click **Finish**.

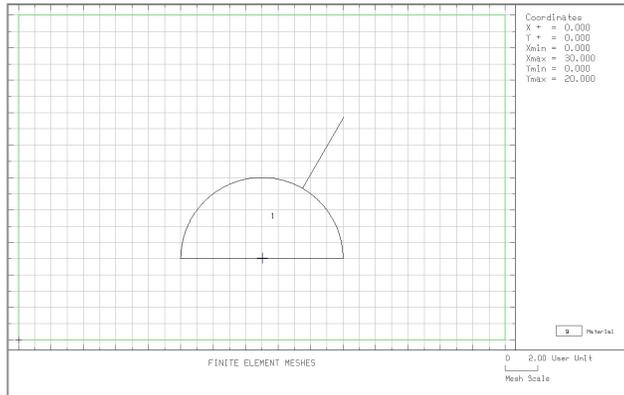


Figure 5.26 Rock Bolt 1 on drawing board

**Step 21: Group No 3 & 4 for Rock Bolt 2 & 3**

Repeat Steps 16 through 20 to add rock bolts at 90 and 120 degrees.  
All three rock bolts are shown on drawing board in Figure 5.27.  
Click **Save** button in **Group** dialog.

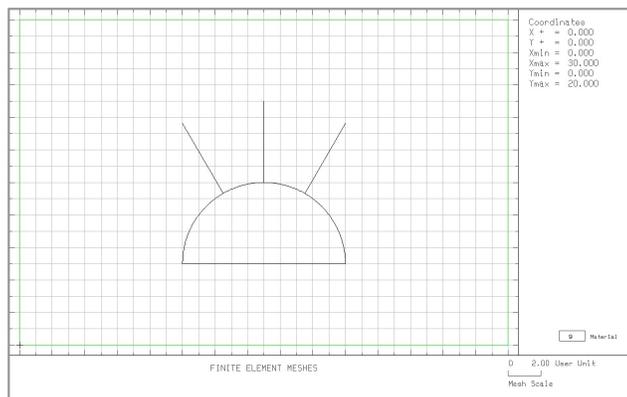


Figure 5.27 All three rock bolts on drawing board

**Step 22: Finite Element Mesh**

Click **F.E. Mesh Plot** button in **Group** dialog.

Follow the same procedure as in Steps 10 and 11.

Finite element meshes are shown in Figure 5.28

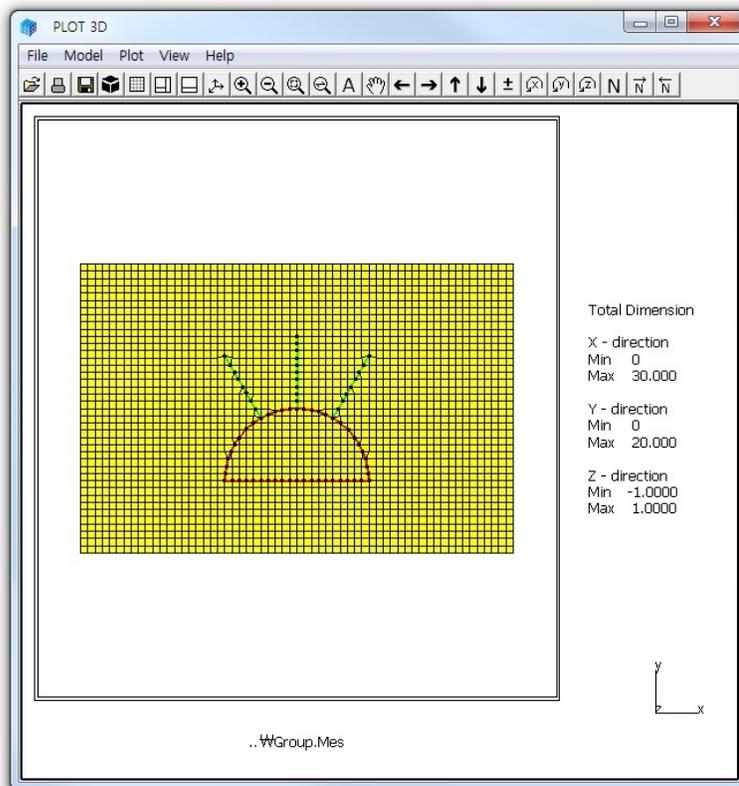


Figure 5.28 Finite element mesh plot

**Step 23: Exit**

Click **Exit** button in **Group** dialog.

Click **OK** in **Exit dialog** as in Figure 5.22.

### 5.1.3 Part 3: Adding Utility Tunnel

Part 3 consists of the following main actions:

- Open the group mesh file in part 2
- Remove the first rock bolt
- Change the second rock bolt length
- Replace the third rock bolt by utility tunnel
- Plot finite element mesh

#### Step 24: Open Group Mesh File in Part 2

Follow Steps 13 through 15 to open Group dialog for Group No 2.

#### Step 25: Remove Rock Bolt 1

Select Group No 2 in Group dialog.

Click MTYPE button in Group dialog.

Select MTYPE=0 in MTYPE dialog in Figure 5.10.

Click OK.

Click Update and then Replot buttons in Group dialog.

A new plot with the Group No 2 missing is displayed in Figure 5.29

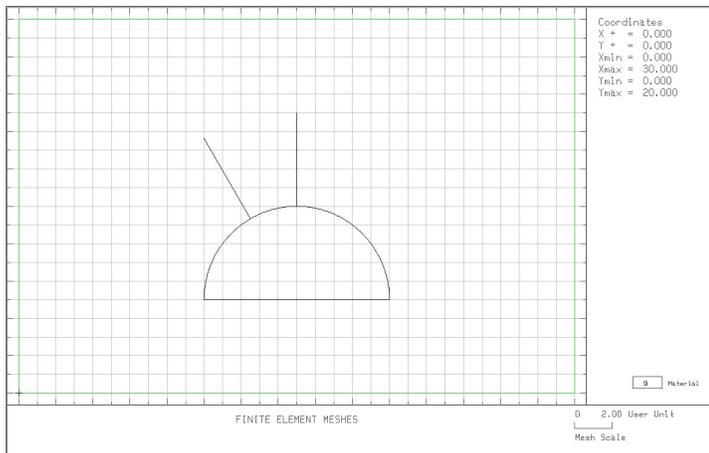


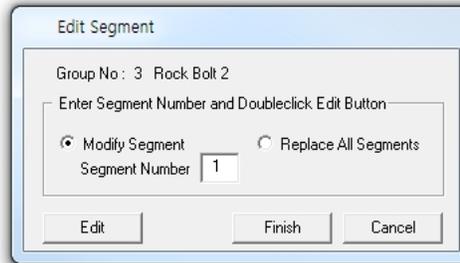
Figure 5.29 Rock Bolt 1 removed on drawing board

## Step 26: Change Length of Rock Bolt 2

Select Group No 3 in **Group** dialog.  
Click **Edit Group** button in **Group** dialog.

Click **Edit** button in **Edit Segment** dialog in Figure 5.30.

Figure 5.30  
Edit segment dialog  
for Group No 3



Fill in input fields for **Arc Segment** dialog as shown in Figure 5.31.  
Click **Draw** and then **Finish** in **Arc Segment** dialog.  
Click **Finish** in **Edit Segment** dialog.

Figure 5.31  
Arc segment dialog with  
rock bolt length modified

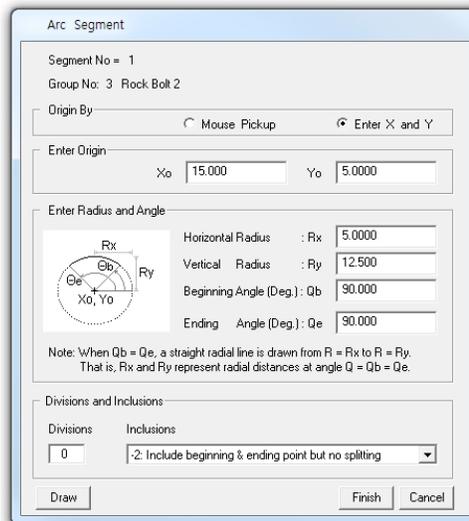


Figure 5.32 shows a new plot with longer Rock Bolt 2.

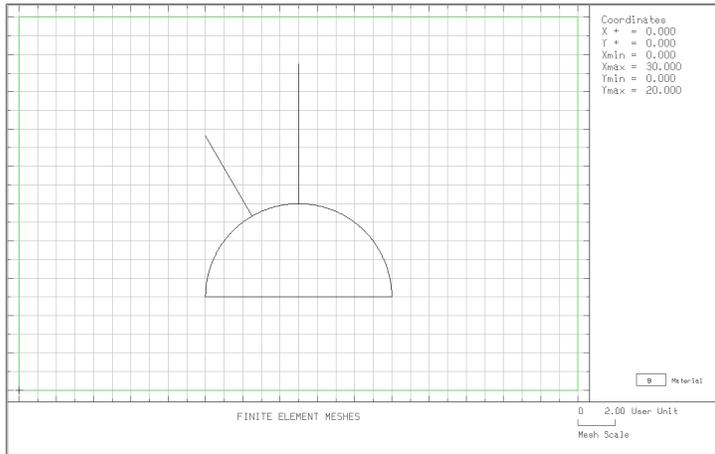


Figure 5.32 Longer Rock Bolt 2 on drawing board

**Step 27: Replace Rock Bolt 3 by Utility Tunnel**

Select Group No 4 in **Group** dialog.

Click **MTYPE** button in **Group** dialog.

Select **MTYPE=1** in **MTYPE** dialog in Figure 5.10.

Click **OK**.

Fill in input fields for **Group** dialog as shown in Figure 5.33.

Click **Edit Group**.

Group

Group Identity

Group No: 4 < > Title: Utility Tunnel

MType and Material Parameter

1: Generate lines & remove elements within closed loop

MATNO: 1 IDH: 0.00 MATold: 3 MTYPE

MATNDi: 0 IDHi: 0.00 THICi: 0.10 Description

LTP: 2 LFUN: 2 Add new mesh Hide

LTPi: 2 LFUNi: 1 Line Options

LTPo: 2 LFUNo: 2 Color Type Thickness

Coordinate Constraint

Generated coordinates are movable  Generated coordinates are not movable

Element Activity

	NAC	NDAC
LFUN	0	0
	0	0
	0	0
	5	999
	0	0
	0	0

PLOT-2D Plot

Mesh

Principal Stress

Deformed Shape

Beam

Truss

Contour

Reference Line

Translation

Geometry will be moved by distance Dx and Dy in X and Y direction

Dx: 0.00

Dy: 0.00

cut inside

Edit Group

Show Number

Update

Save

Base Mesh

Replot

Group Editor

Segment Editor

F.E. Mesh Plot

Close

Exit

Figure 5.33 Group dialog for Utility Tunnel

Select **Replace All Segments** in **Edit Segment** dialog in Figure 5.34  
Click **Edit**.

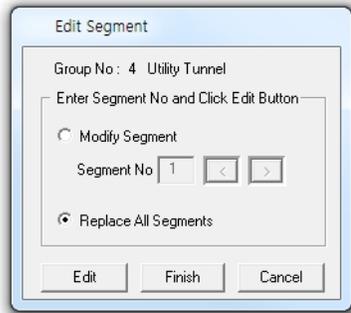


Figure 5.34 Edit segment dialog for Group No 4

**Warning** message is displayed as shown in Figure 5.35.  
Click **OK**.

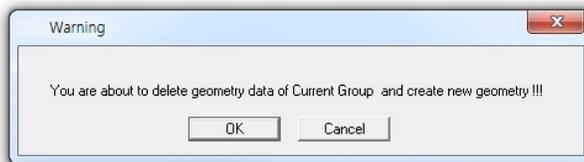


Figure 5.35 Warning message

Fill in input fields for **Arc Segment** dialog as shown in Figure 5.36.  
Click **Draw** and then **Finish** in **Arc Segment** dialog.  
Click **Finish** in **Edit Segment** dialog in Figure 5.34.

Arc Segment

Segment No = 1  
Group No: 4 Utility Tunnel

Origin By:  Mouse Pickup  Enter X and Y

Enter Origin:  
X0: 7.5 Y0: 12.5

Enter Radius and Angle

Horizontal Radius : Rx 2.5  
Vertical Radius : Ry 2.5  
Beginning Angle (Deg.) : Qb 0  
Ending Angle (Deg.) : Qe 360

Note: When Qb = Qe, a straight radial line is drawn from R = Rx to R = Ry.  
That is, Rx and Ry represent radial distances at angle Q = Qb = Qe.

Divisions and Inclusions  
Divisions: 0  
Inclusions: 2. Include beginning & ending point

Draw Line Segment Finish Cancel

Figure 5.36 Arc segment dialog for Utility Tunnel

Click **Update** and then **Replot** buttons in **Group** dialog.  
Figure 5.37 shows a new plot with Utility Tunnel on drawing board.

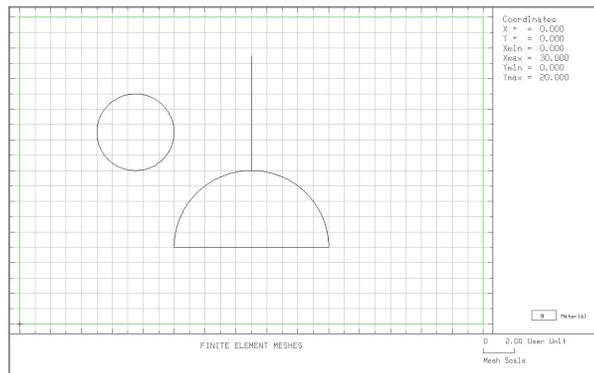


Figure 5.37 Arch and Utility Tunnels on drawing board

### Step 28: Finite Element Mesh

Click [Save](#) and [F.E. Mesh Plot](#) button in [Group](#) dialog.  
Follow the same procedure as in Steps 10 and 11.  
Finite element meshes are shown in Figure 5.38

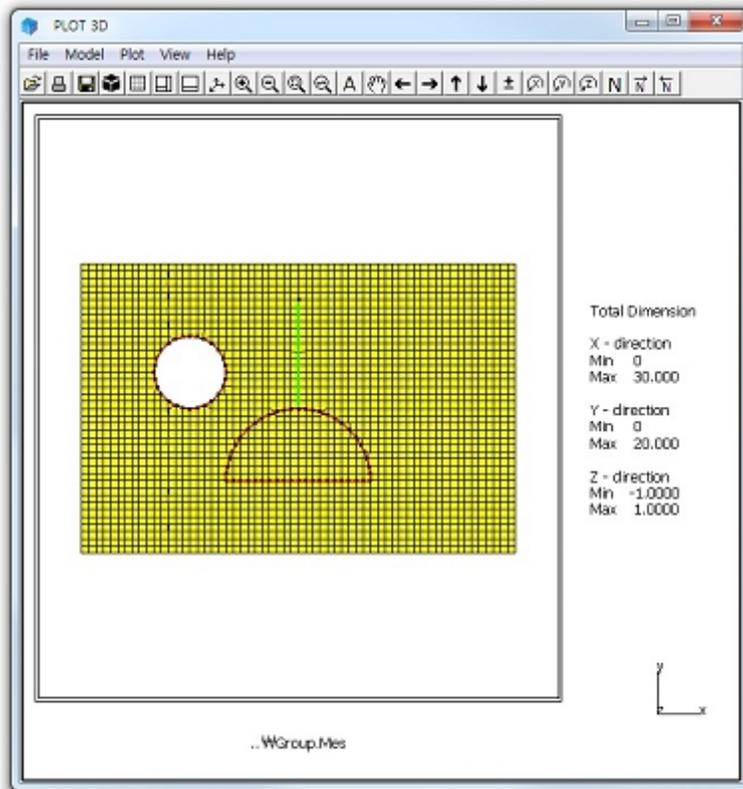


Figure 5.38 Finite element mesh plot

### Step 29: Exit

Click [Exit](#) button in [Group](#) dialog.  
Click [OK](#) in [Exit dialog](#) as in Figure 5.22.

## 5.2 Finite Element Mesh Modification

This example illustrates how to modify existing finite element meshes using [Mesh Generator](#).

### 5.2.1 Overview

When you open input file, [Mesh Generator](#) reads the extension of the input file name and it assumes that the input file is the finite element mesh file if the extension is [.Mes](#).

Editing finite element meshes has three parts: [Nodal Boundary](#), [Nodal Coordinate](#) and [Element Material](#). These editing modes can be accessed from [Mesh](#) menu in [PLOT-2D](#) as shown in Figure 5.39.

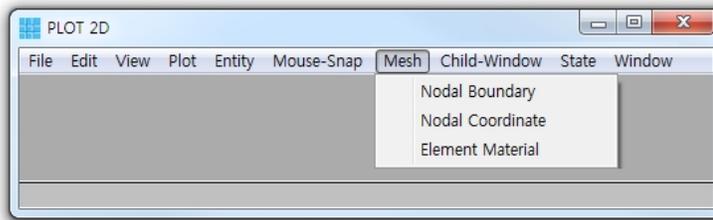


Figure 5.39 Menu for editing finite element mesh

It should be noted that once you edited the finite element meshes, modified finite element mesh is saved as [MeshFile.Mes](#) in the current working directory. The original input mesh file is not changed.

Figure 5.40 shows existing finite element mesh with six layers of natural soils. The top layer of this existing mesh is to be replaced by sand embankment with reduced width as schematically shown in Figure 5.41.

This modification involves following three works:

- Change top surface nodal coordinates
- Change top surface nodal boundaries
- Change top layer element materials

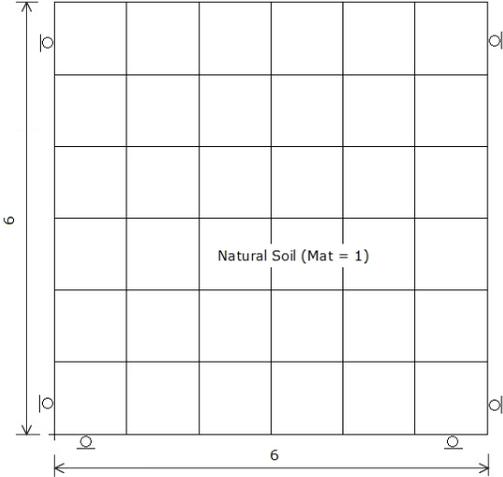


Figure 5.40 Existing finite element mesh

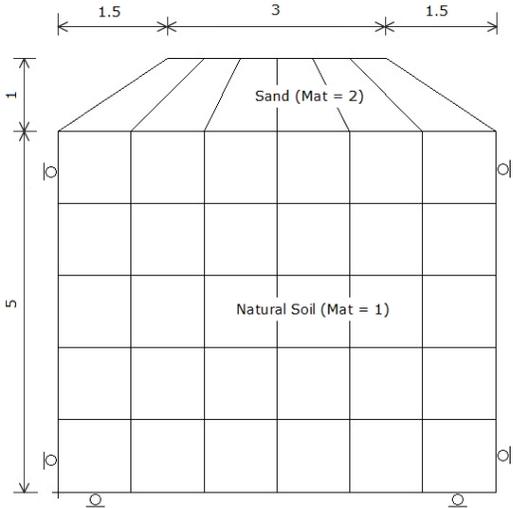


Figure 5.41 Modified finite element mesh

### 5.2.2 Change Top Surface Nodal Coordinates

Click **Nodal Coordinate** from the **Mesh** menu, then **Edit Coordinate** dialog in Figure 5.42 is displayed.

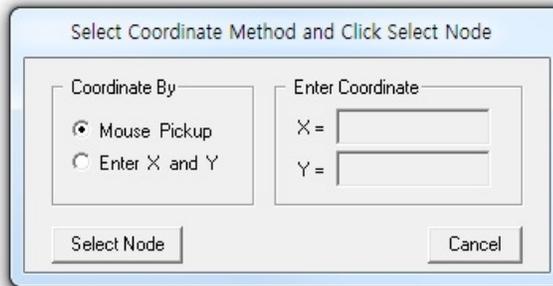


Figure 5.42 Edit coordinate dialog

For this example, **Snap to Half of Grid** in Figure 5.43 is the most convenient method for **Mouse Pickup**.

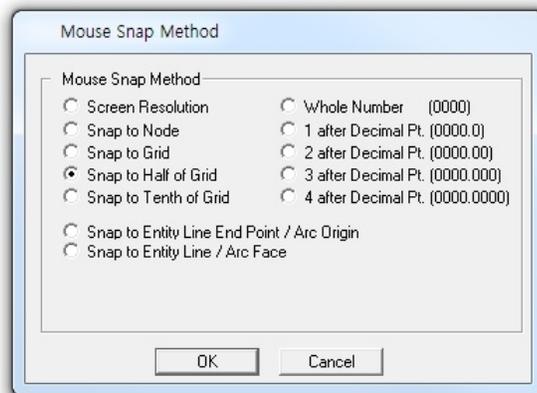


Figure 5.43 Mouse snap method

Click **Select Node** in Figure 5.42.

When you select the node by **Mouse Right Click**, the selected node is marked as an open circle on the drawing board as in Figure 5.44.

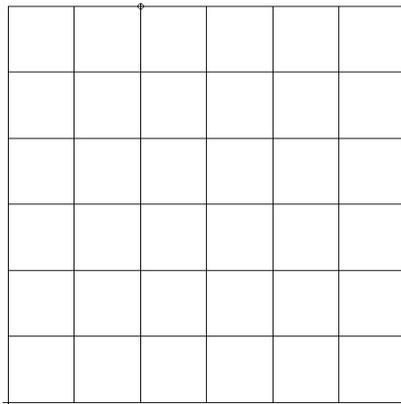


Figure 5.44 First selected node on drawing board

Now, move the first selected node by using drag-and-drop of **Mouse Left Button** as shown in Figure 5.45.

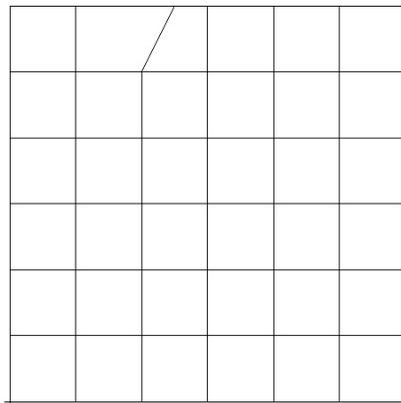


Figure 5.45 New position of first selected node

Select the next node by **Mouse Right Click** as shown in Figure 5.46.

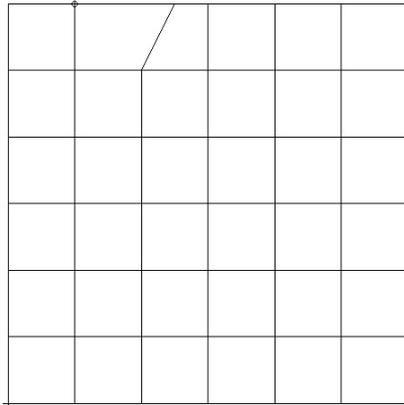


Figure 5.46 Second selected node on drawing board

Now, move the second selected node by using drag-and-drop of **Mouse Left Button** as shown in Figure 5.47.

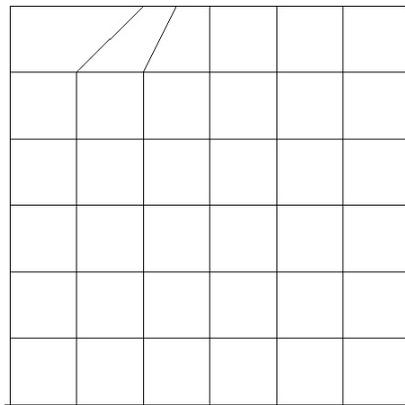


Figure 5.47 New position of second selected node

Repeat the same procedure for all other nodes on the top surface. Once finished, click **Finish** button in Figure 5.48.

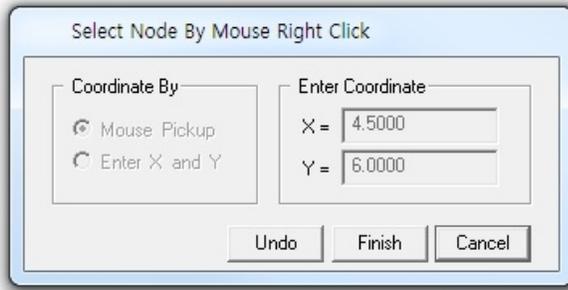


Figure 5.48 Edit coordinate dialog

Figure 5.49 shows final finite element mesh on the drawing board.

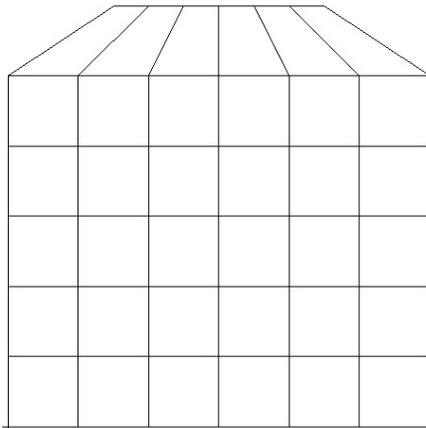


Figure 5.49 Final finite element mesh

### 5.2.3 Change Top Surface Nodal Boundaries

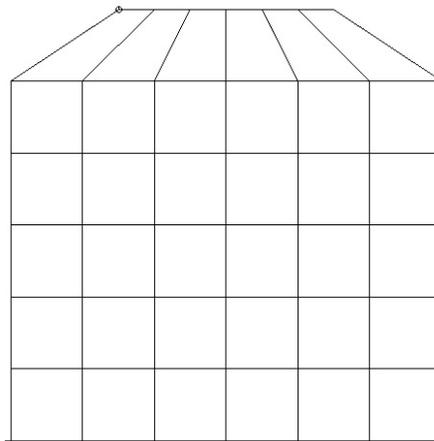
Click **Nodal Boundary** from the **Mesh** menu, then **Edit Boundary Code** dialog in Figure 5.50 is displayed.

Figure 5.50  
Edit boundary dialog

Figure 5.50 shows the "Edit Boundary Code" dialog box. The dialog is titled "Edit Boundary Code". It features a "Node Number By" section with two radio buttons: "Mouse Pickup" (selected) and "Enter Node No". To the right of the radio buttons is a text box containing the number "1". Below this is a "New Boundary Code" section with two input fields: "ID" (containing "0") and "IDF" (containing "0"). Below these fields is explanatory text: "ID = 0 for Heat Flow, ID = 1 for Temperature" and "IDF is Time History Identification No". At the bottom of the dialog are "Select Node" and "Cancel" buttons.

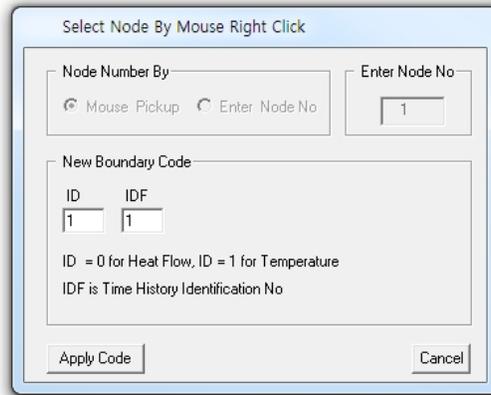
Click **Select Node** in Figure 5.50. When you select the node by **Mouse Right Click**, the selected node is marked as an open circle on the drawing board as in Figure 5.51.

Figure 5.51  
Selected node on drawing board



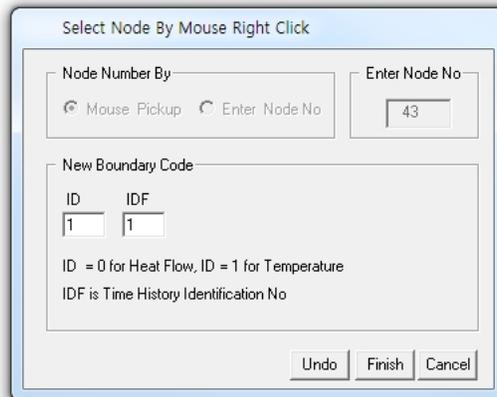
Change the boundary codes as in Figure 5.52 so that the top left node is specified by temperature and then click **Apply Code** button.

Figure 5.52  
Modified boundary code for top left node



In the same way, select the top right node, modify boundary codes, and click **Apply Code**. Since all boundary codes are modified, click **Finish** button in Figure 5.53.

Figure 5.53  
Modified boundary code for top right node



Click **General View** from the **View** menu. Select **Heat Boundary Code** in **General View Options** dialog as shown in Figure 5.54 and then click **OK** button. Modified flow boundary codes are shown in Figure 5.55.

Figure 5.54  
General view  
for heat boundary code

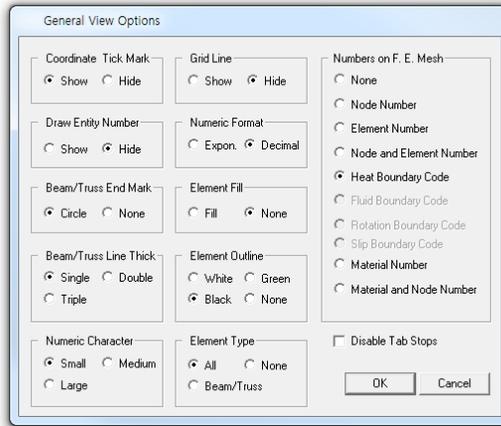
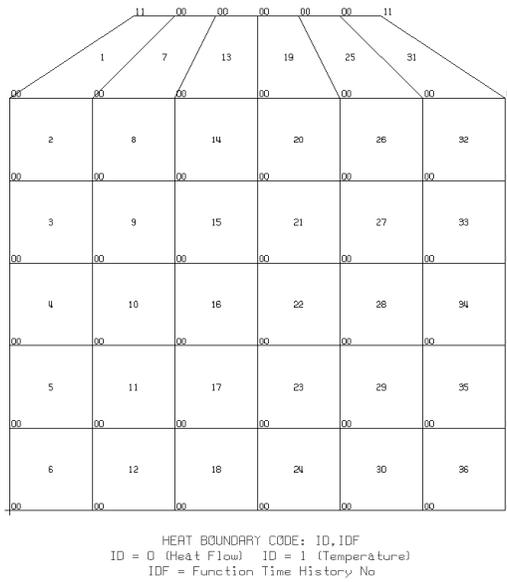


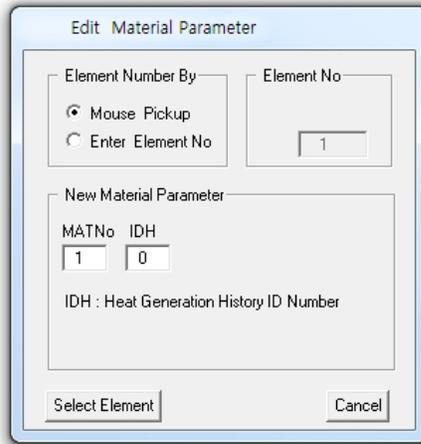
Figure 5.55  
Modified heat  
boundary code plot



### 5.2.4 Change Top Layer Element Materials

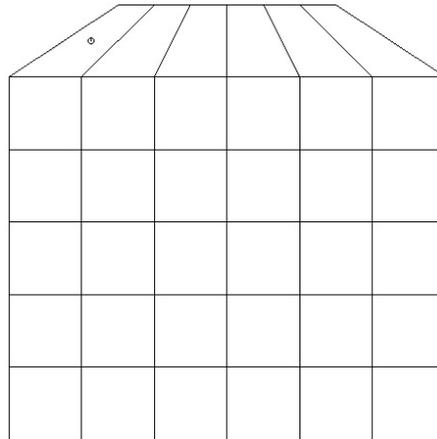
Click **Element Material** from the **Mesh** menu, then **Edit Material Parameter** dialog in Figure 5.56 is displayed.

Figure 5.56  
Edit element material dialog



Click **Select Element** button.  
Click the element on the top layer by **Mouse Right Click**.  
Selected element is marked as an open circle as shown in Figure 5.57.

Figure 5.57  
Selected element on drawing board



Change the material number as shown in Figure 5.58 and then click **Apply** button.

Figure 5.58  
Modified material number  
for element 1

The dialog box is titled "Select Element By Mouse Right Click". It contains two radio buttons under "Element Number By": "Mouse Pickup" (selected) and "Enter Element No". To the right is an "Element No" input field containing the value "1". Below this is a "New Material Parameter" section with two input fields: "MATNo" containing "2" and "IDH" containing "0". A label below these fields reads "IDH : Heat Generation History ID Number". At the bottom are "Apply" and "Cancel" buttons.

Repeat the same procedure for the other elements on the top layer. Once finished, click **Finish** button in Figure 5.59.

Figure 5.59  
Modified material number  
for element 31

The dialog box is titled "Select Element By Mouse Right Click". It contains two radio buttons under "Element Number By": "Mouse Pickup" (selected) and "Enter Element No". To the right is an "Element No" input field containing the value "31". Below this is a "New Material Parameter" section with two input fields: "MATNo" containing "2" and "IDH" containing "0". A label below these fields reads "IDH : Heat Generation History ID Number". At the bottom are "Apply", "Finish", and "Cancel" buttons.

Click **General View** from the **View** menu. Select **Material Number** in **General View Options** dialog as shown in Figure 5.60 and then click **OK** button. Modified material number is shown in Figure 5.61.

Figure 5.60  
General view  
for material number

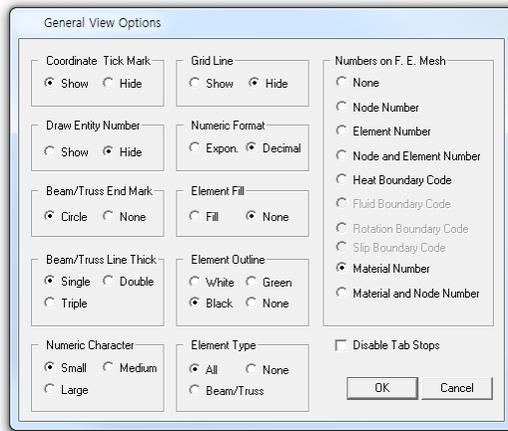
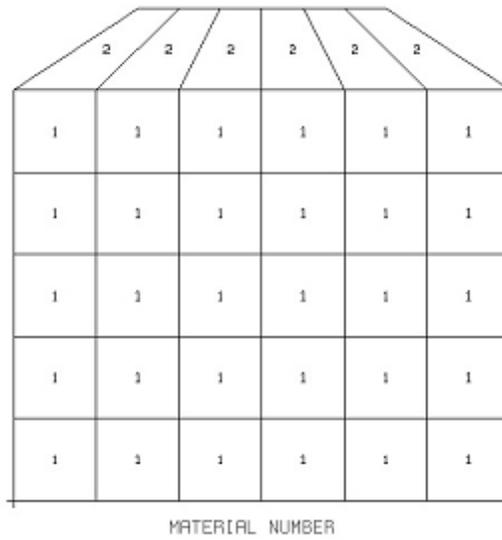


Figure 5.61  
Modified material number  
plot



## **Block Mesh Example Problem**

[Block Mesh Generator](#) is a three-dimensional CAD program specially designed to build block mesh which can be used to generate finite element mesh with the aid of program [PRESMAP-GP](#). [Block Mesh User's Manual](#) describes all the basic functions associated with block mesh generation and modifications.

Two example problems are presented:

1. [Single Element](#)  
Shows step-by-step procedure to create block mesh.
2. [Cube Earth Dam](#)  
Builds block mesh for cube earth dam.

## 6.1 Single Element

The main objective of this first example is to show the step-by-step procedure to create block mesh.

This example is to build single cube element in Figure 6.1 by using block mesh generator. This single element is subjected to total head change through top surface.

This example involves following seven main steps:

1. Access block mesh generator
2. Set work plane
3. Build cube entity
4. Build hexahedron block
5. Edit block boundary code
6. View water flow boundary code
7. Plot finite element mesh

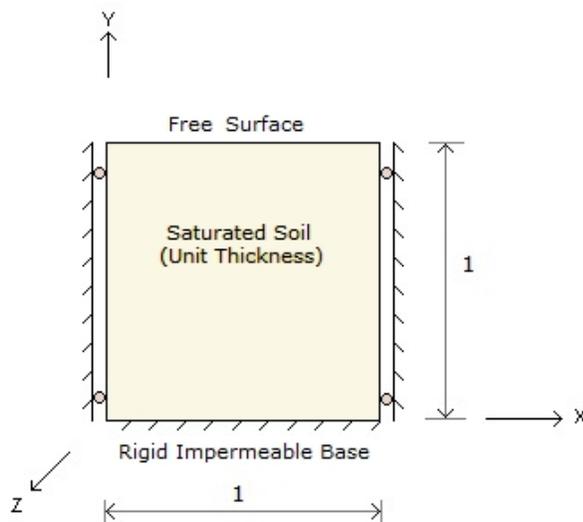


Figure 6.1 Single element

### Step 1: Access Block Mesh Generator (New)

Access **Block Mesh Generator** by following menu items in **SMAP**  
**Run** → **Mesh Generator** → **Block Mesh** → **New**

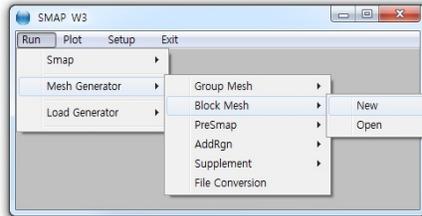


Figure 6.2 Accessing block mesh generator

### Step 2: Set Work Plane

**Prebuilt Work Plane** is displayed on drawing board along with **Work Plane Editor** dialog. Modify **NDx** and **Wx** in Figure 6.3 and click **Update**.

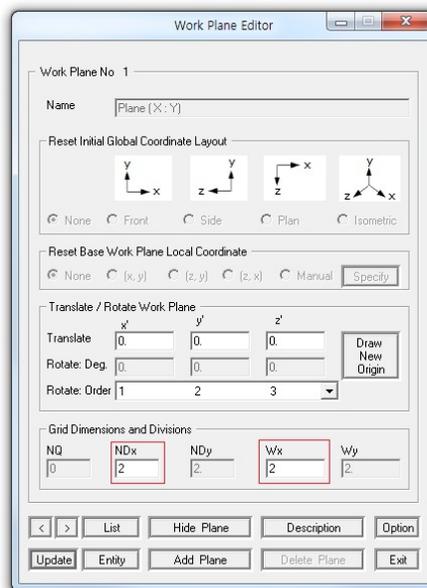


Figure 6.3 Work plane editor

### Step 3: Build Cube Entity

1. Click **Entity** button in Figure 6.3.
2. **Entity Editor** dialog is displayed as in Figure 6.4.

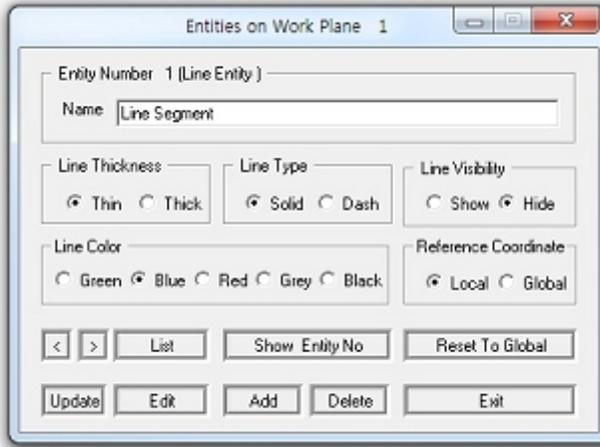


Figure 6.4 Entity editor

3. Click **Add** button in Figure 6.4.
4. Select **Cube** entity and click **OK** button in Figure 6.5.

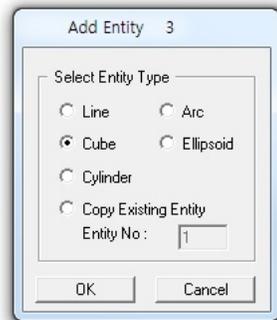


Figure 6.5 Entity type selection

5. Modify input fields of  $L_x$ ,  $L_y$ , and  $L_z$  as shown in Figure 6.6.
6. Click **Draw Cube Entity** button.

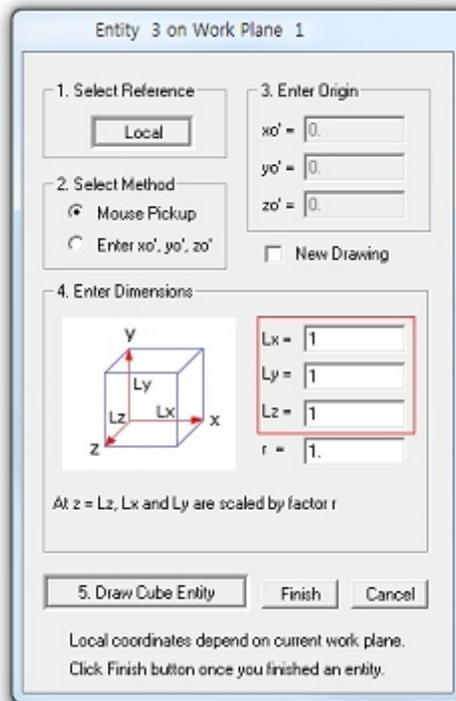


Figure 6.6 Cube entity

7. [Coordinates on Work Plane](#) dialog is displayed as in Figure 6.7.
8. Click [Info](#) button to see the notes on [Mouse Actions on Work Plane](#) as shown in Figure 6.8.

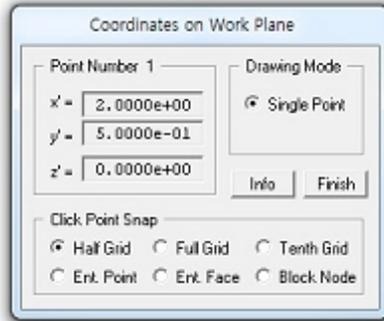


Figure 6.7 Coordinates on work plane

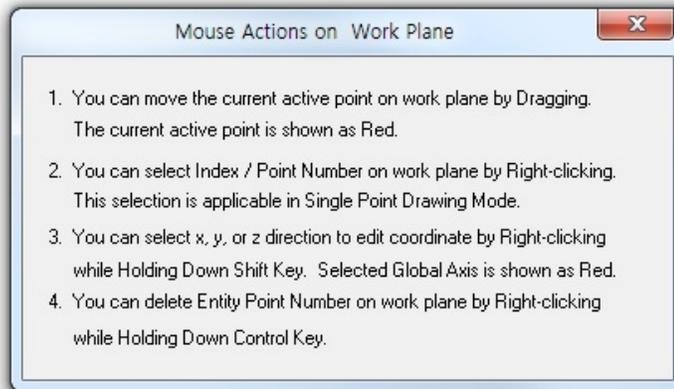


Figure 6.8 Mouse actions on work plane

9. Click **Axis** toolbar as shown in Figure 6.9.

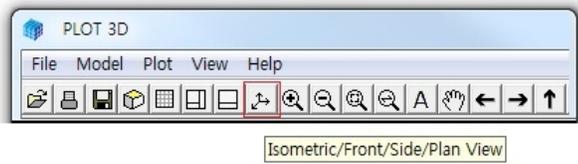


Figure 6.9 Axis toolbar

10. Click **Mouse** at the origin of coordinates.  
11. **Cube** entity is shown on isometric work plane in Figure 6.10.

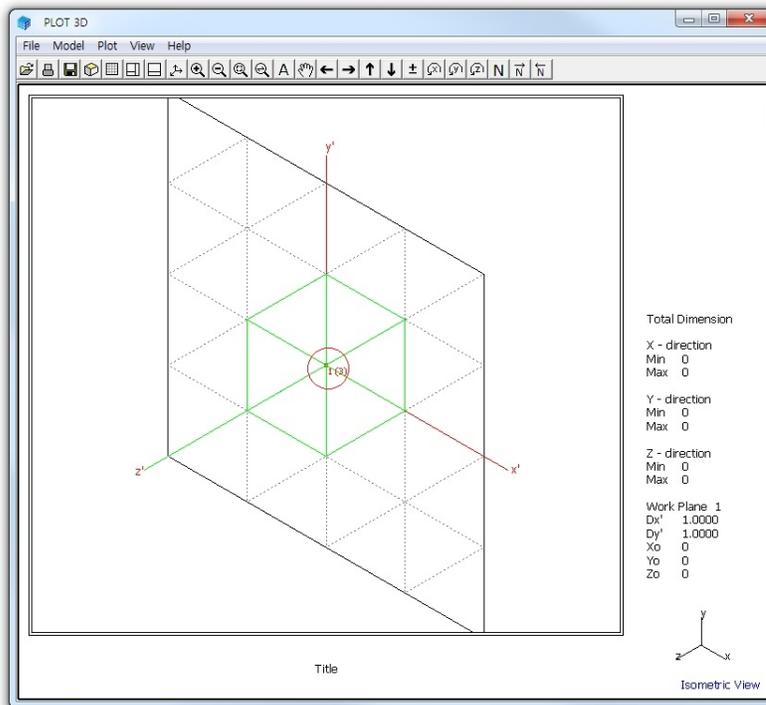


Figure 6.10 Cube entity on isometric work plane

12. Click **Finish** in Figure 6.7.
13. Click **Finish** in Figure 6.6.
14. Select **Global** for **Reference Coordinate** in Figure 6.11.
15. Click **Reset To Global** and then **Exit** buttons in Figure 6.11.

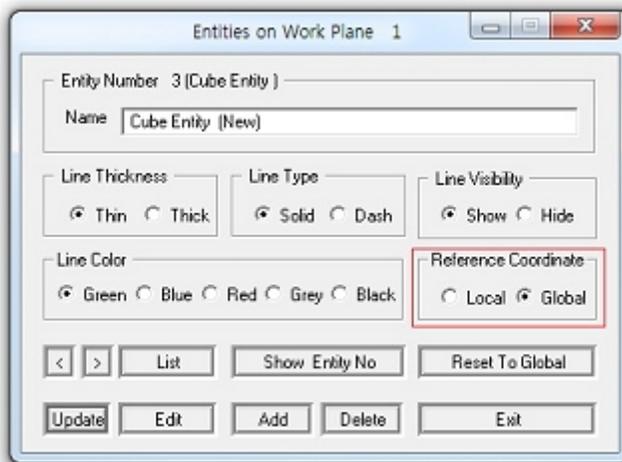


Figure 6.11 Entity editor

**Step 4: Build Hexahedron Block**

1. Click **Block Editor** toolbar in Figure 6.12.

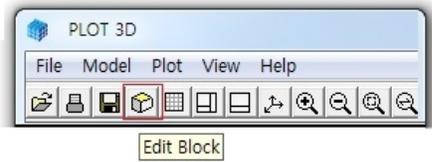


Figure 6.12 Block editor toolbar

2. Select **Hexa** for block type and click **OK** in Figure 6.13.

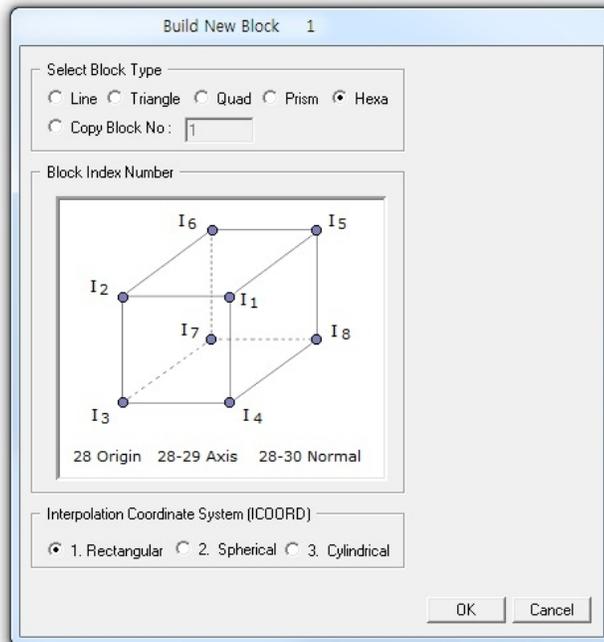


Figure 6.13 Block type selection

## 6-10 Block Mesh Example

3. Click **Draw Index Number** in Figure 6.14.
4. **Coordinates on Work Plane** dialog is displayed in Figure 6.15.

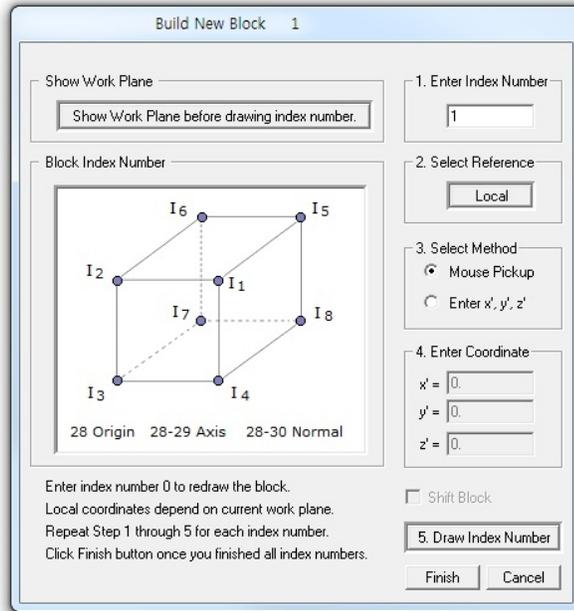


Figure 6.14 Hexa block

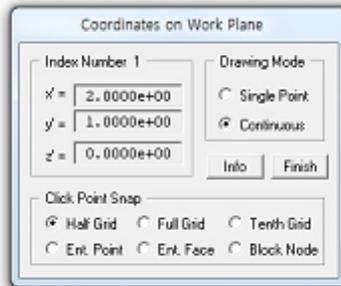


Figure 6.15 Coordinates on work plane

5. Translate work plane as in Figure 6.16 and click **Update** button.

Translate / Rotate Work Plane			
	$x'$	$y'$	$z'$
Translate	0.	0.	1
Rotate: Deg.	0.	0.	0.
Rotate: Order	1	2	3

Draw New Origin

Figure 6.16 Work plane translation ( $z' = 1$ )

6. Click the points for index numbers on front surface as in Fig 6.17.

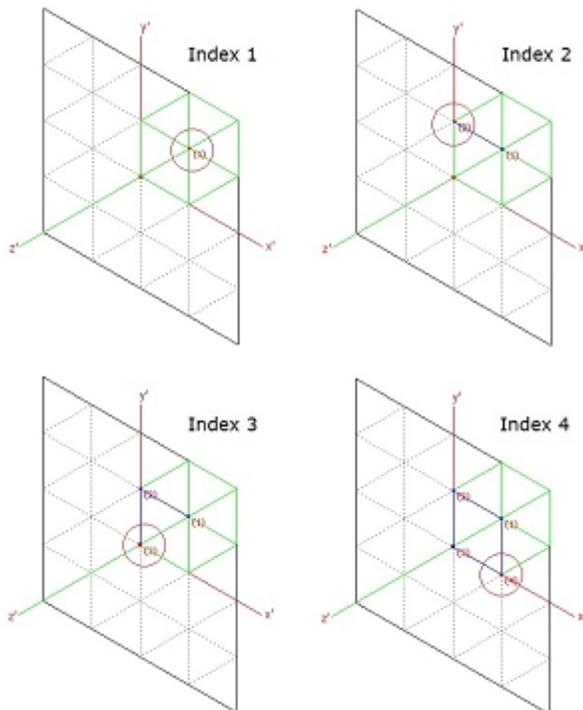


Figure 6.17 Index numbers on front surface

7. Translate work plane as in Figure 6.18 and click [Update](#) button.

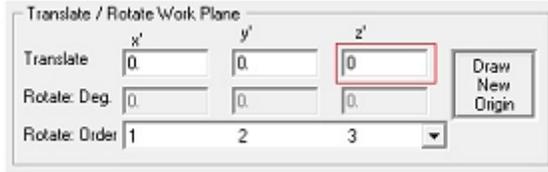


Figure 6.18 Work plane translation ( $z' = 0$ )

8. Click the points for index numbers on back surface as in Fig 6.19.

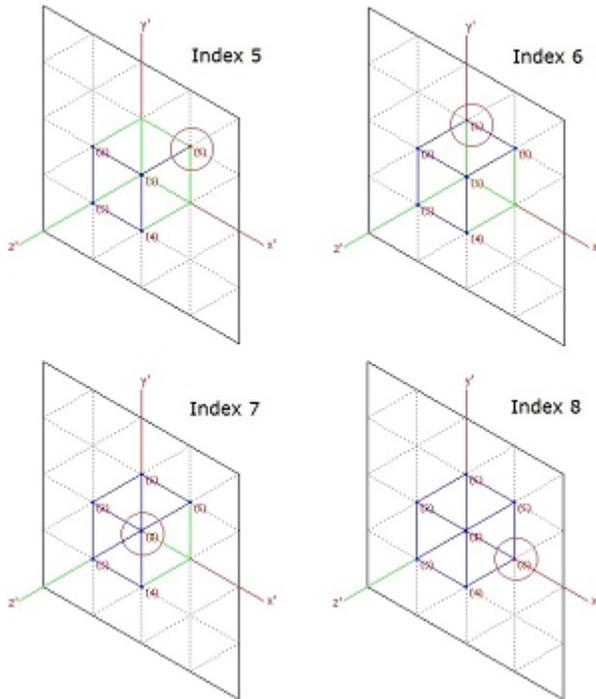


Figure 6.19 Index numbers on back surface

Now, the geometry of hexahedron block is completed.

- Click [Finish](#) in Figure 6.20 and then click [Finish](#) in Figure 6.14.

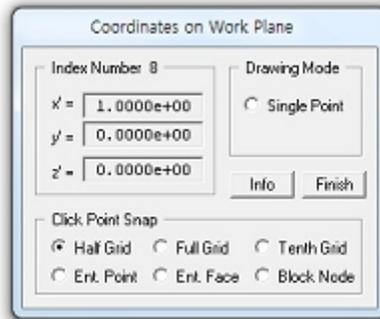


Figure 6.20 Coordinates on work plane

- Get back to [Work Plane Editor](#) dialog and click [Entity](#).
- Select [Entity Number 3](#), [Hide](#) for line visibility, click [Update](#), and click [Exit](#) in Figure 6.21.

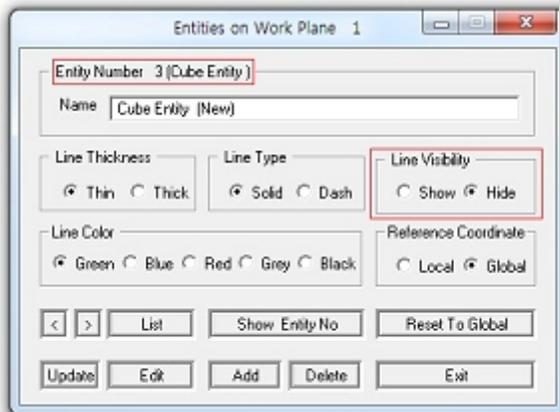


Figure 6.21 Entity editor

## 6-14 Block Mesh Example

12. Modify **Title** and **Material & Element Generation Parameters** in **Block Editor** as shown in Figure 6.22.
13. Click **Save** and type in file name as **EX1**.

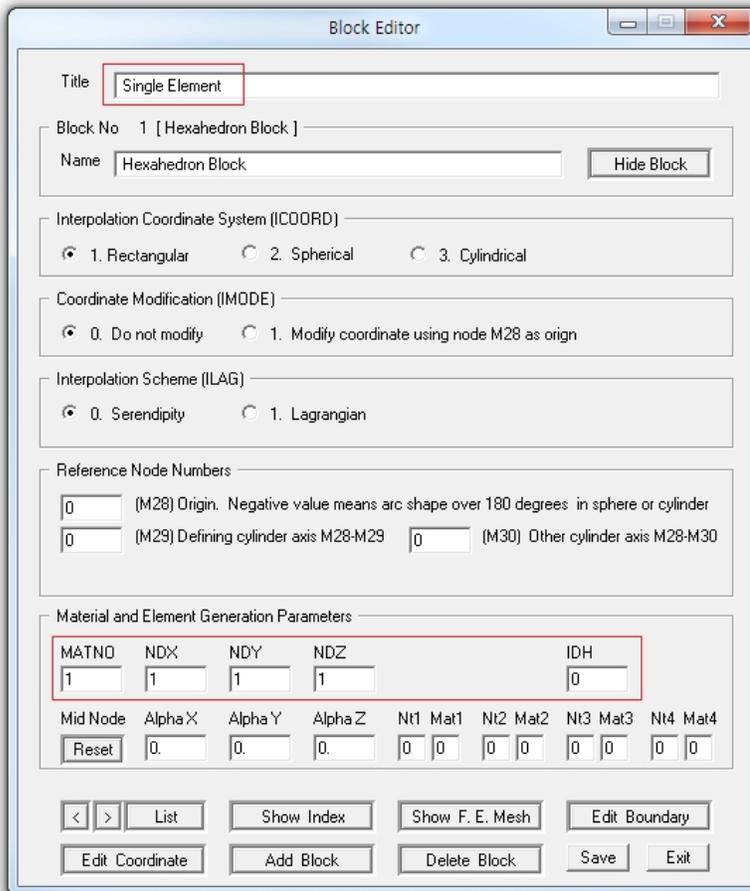


Figure 6.22 Block editor

**Step 5: Edit Block Boundary Code**

1. Click **Edit Boundary** in Figure 6.22.
2. Set the boundary codes as shown in Figure 6.23.
3. Click **IBTYPE** button to see description of boundary in Figure 6.24.
4. Click **Update** and then **OK** buttons.

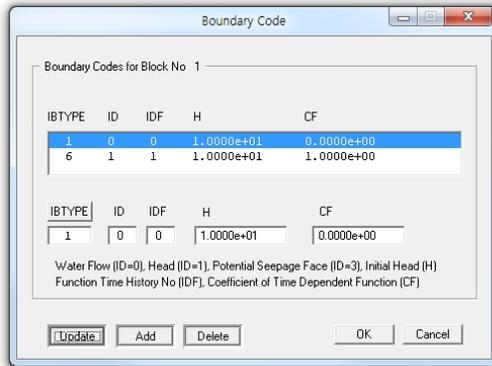


Figure 6.23 Boundary code editor

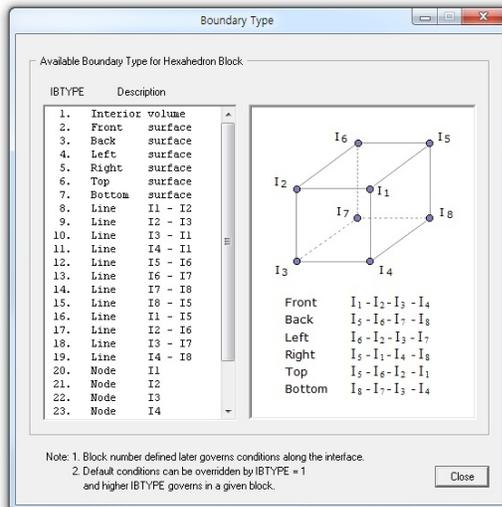


Figure 6.24 Boundary type for hexa block

### Step 6: View Water Flow Boundary Code

1. Select **View** → **General** in PLOT-3D menu.
2. Select **Water Flow Boundary Code** and click **OK** in Figure 6.25.
3. Click **Save** in Figure 6.22.



Figure 6.25 General view options

- Click **Show Numbers** toolbar as shown in Figure 6.26.



Figure 6.26 Show numbers toolbar

- Water flow boundary codes are shown in Figure 6.27.

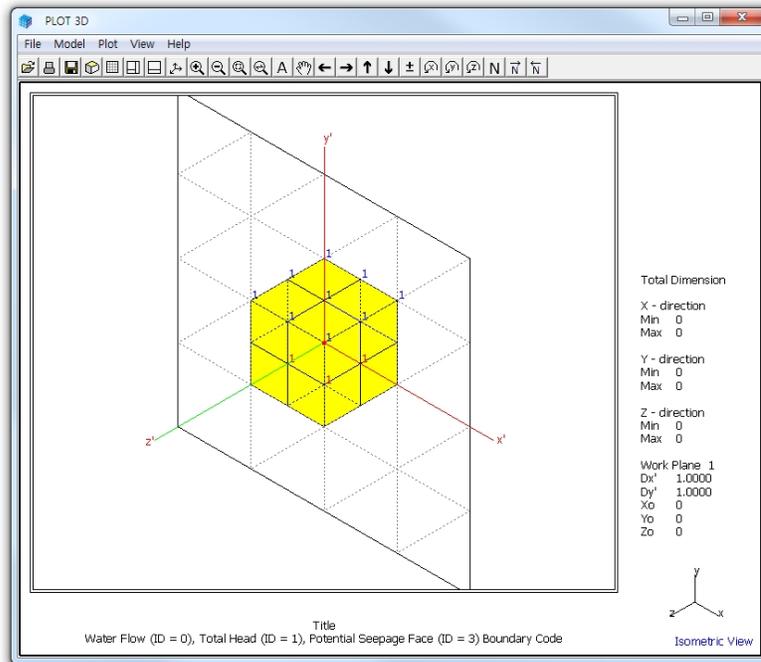


Figure 6.27 Water flow boundary codes on drawing board

### Step 7: Plot Finite Element Mesh

1. Click **Show F. E. Mesh** in Figure 6.22.
2. Rotate the finite element mesh as shown in Figure 6.28.

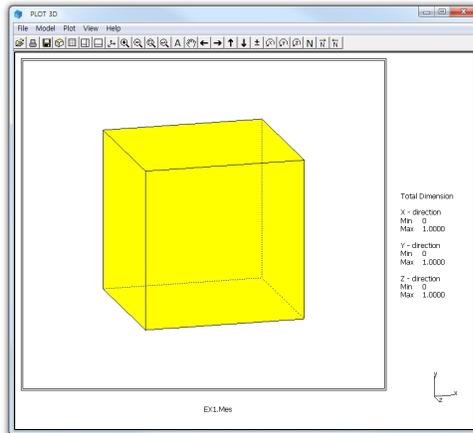


Figure 6.28 Finite element mesh

3. Follow same procedure to plot waterflow boundary in Step 6.
4. Figure 6.29 shows water flow boundary code.

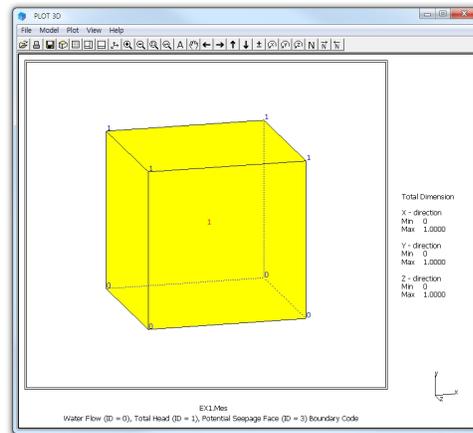


Figure 6.29 Water flow boundary codes

## 6.2 Cube Earth Dam

This example illustrates how to build block mesh for cube earth dam. Cube earth dam has the dimensions of 100 x 100 x 100 units with all impermeable boundaries except total head specified on top surface.

This example has the following two parts:

### Part 1: Creating Cube Earth Dam (Figure 6.30)

- Access block mesh generator (New)
- Set work plane
- Build hexahedron block
- Edit block boundary
- Set global boundary
- View water flow boundary code
- Plot finite element mesh

### Part 2: Modifying Cube Earth Dam (Figure 6.31)

- Access block mesh generator (Open)
- Modify element generation parameters
- Plot finite element mesh

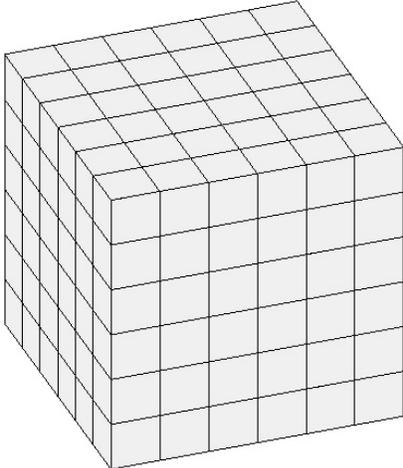


Figure 6.30 Cube earth dam with constant element size

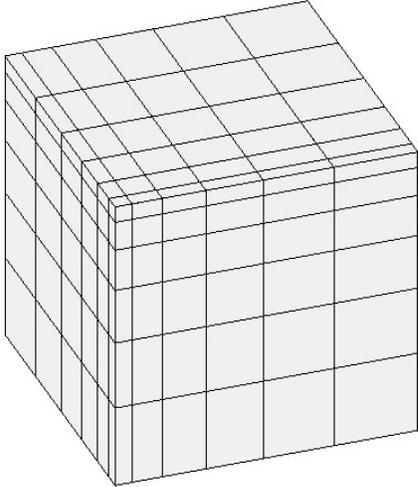


Figure 6.31 Cube earth dam with variable element size

### 6.2.1 Part 1: Creating Cube Earth Dam

Part 1 consists of the following seven main steps:

1. Access block mesh generator (New)
2. Set work plane
3. Build hexahedron block
4. Edit block boundary
5. Set global boundary
6. View water flow boundary code
7. Plot finite element mesh

#### Step 1: Access Block Mesh Generator (New)

Access [Block Mesh Generator](#) by selecting the following menu items in [SMAP](#) (Figure 6.2):

Run → Mesh Generator → Block Mesh → New

#### Step 2: Set Work Plane

Prebuilt [Work Plane](#) is displayed on drawing board along with [Work Plane Editor](#) dialog. Modify [NDx](#) and [Wx](#) in Figure 6.32 and click [Update](#) button.

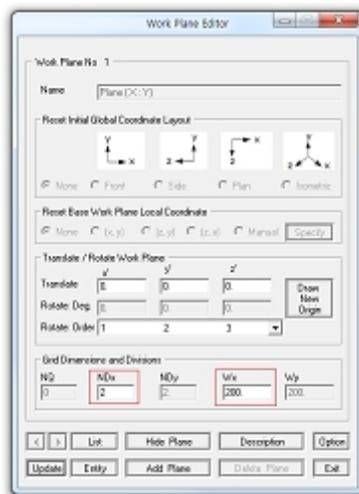


Figure 6.32 Work plane editor

### Step 3: Build Hexahedron Block

Follow the same procedure as in Step 4 in the first example.

1. Click [Axis](#) toolbar as shown in Figure 6.9.
2. Click [Block Editor](#) toolbar in Figure 6.12.
3. Select [Hexa](#) for block type and click [OK](#) in Figure 6.13.
4. Click [Draw Index Number](#) in Figure 6.14.
5. [Coordinates on Work Plane](#) dialog is displayed as in Figure 6.15.

#### [Index Numbers on Front Surface](#)

6. Translate work plane as in Figure 6.33 and click [Update](#) button.
7. Click points for index numbers on front surface as in Fig. 6.34.

#### [Index Numbers on Back Surface](#)

8. Translate work plane as in Figure 6.35 and click [Update](#) button.
9. Click the points for index numbers on back surface as in Fig 6.36.

Now, the geometry of hexahedron block is completed.

10. Click [Finish](#) in Figure 6.20.
11. Click [Finish](#) in Figure 6.14.
12. Modify [Title](#) and [Material & Element Generation Parameters](#) in [Block Editor](#) dialog as shown in Figure 6.37.

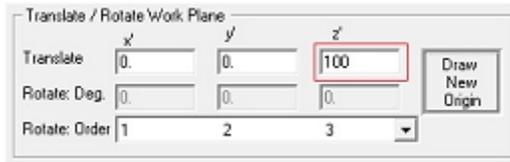


Figure 6.33 Work plane translation ( $z' = 100$ )

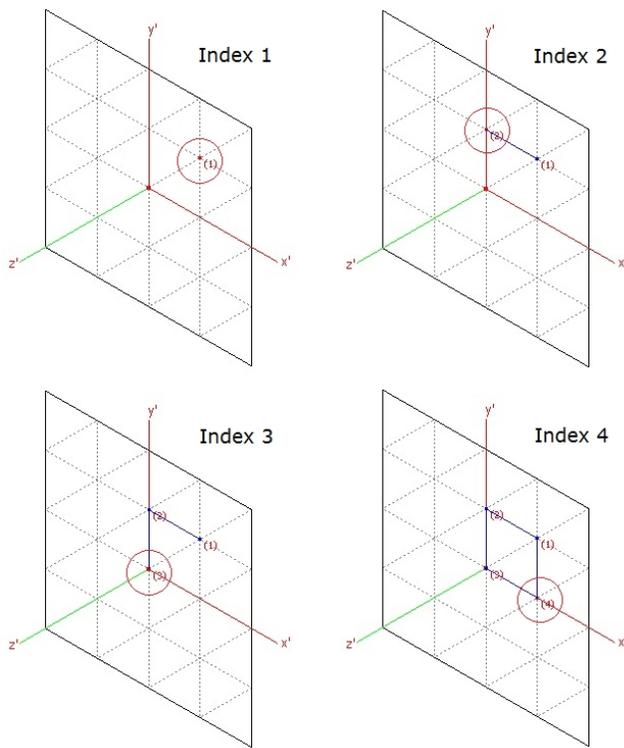


Figure 6.34 Index numbers on front surface



Figure 6.35 Work plane translation ( $z' = 0$ )

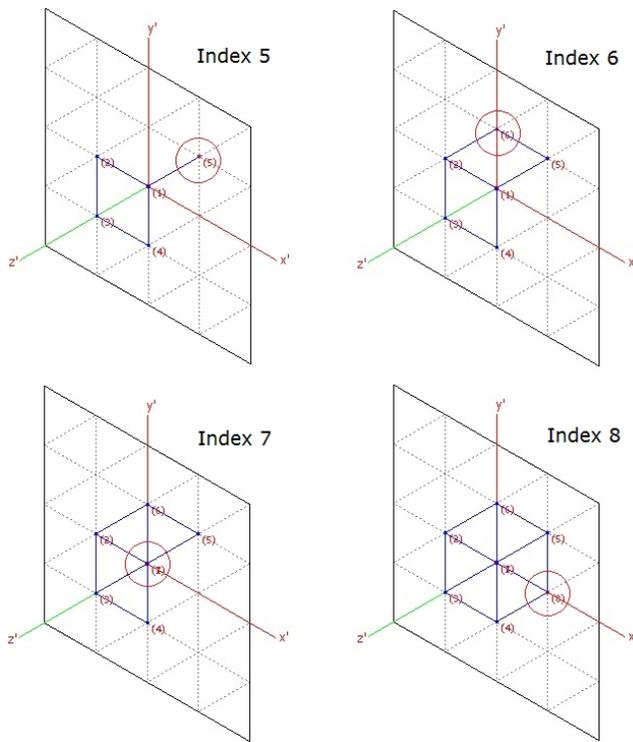


Figure 6.36 Index numbers on back surface

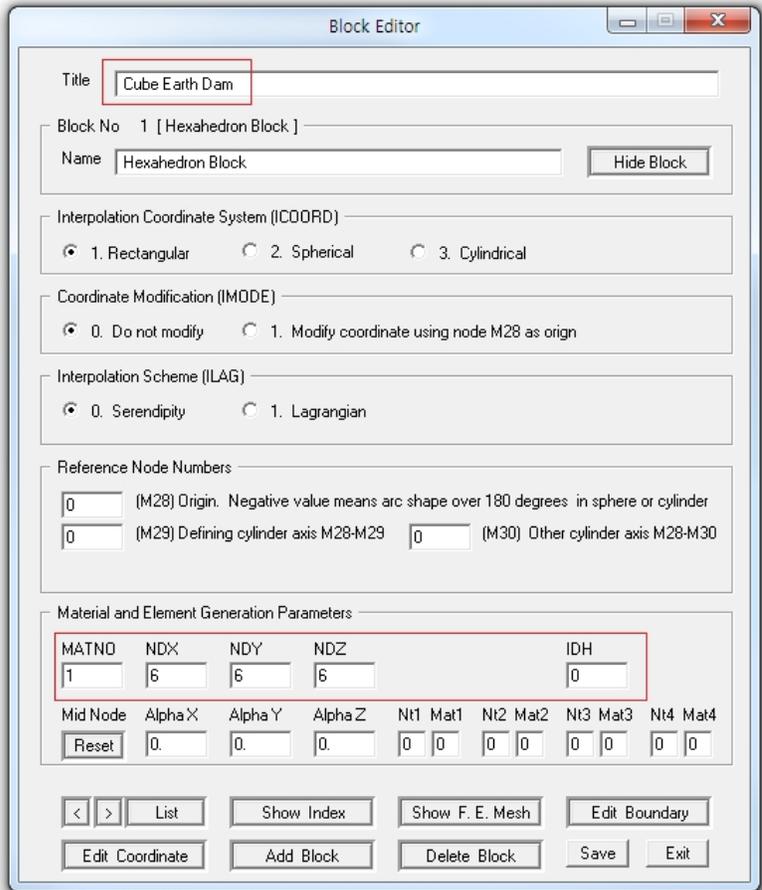


Figure 6.37 Block editor

### Step 4: Edit Block Boundary Code

1. Click **Edit Boundary** in Figure 6.37.
2. Set the boundary codes as shown in Figure 6.38.
3. Click **IBTYPE** button to see description of boundary in Fig. 6.39.
4. Click **Update** and then **OK** buttons in Figure 6.38.

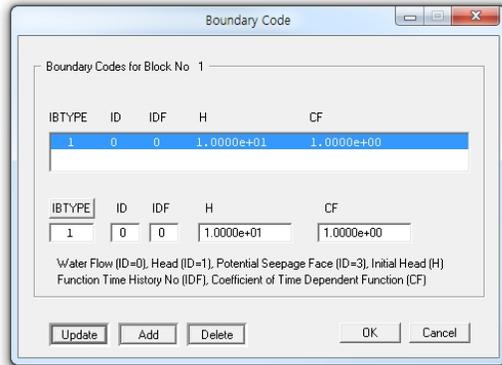


Figure 6.38 Boundary code editor

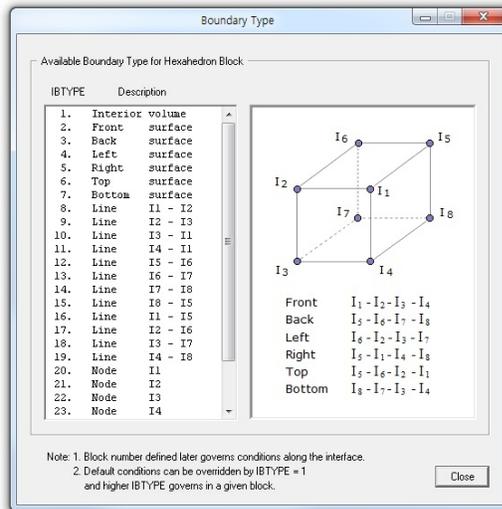


Figure 6.39 Boundary type for hexa block

**Step 5: Set Global Boundary Code**

1. Select **Model** → **Edit Global Boundary** in Figure 6.40.

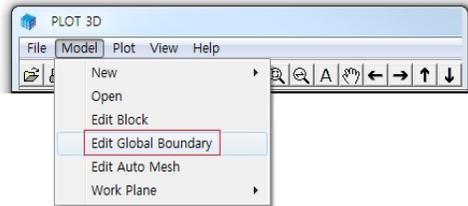


Figure 6.40 Edit global boundary menu

2. Set the boundary codes as shown in Figure 6.41.
3. Select **Yes override block boundary**.
4. Click **Save** and type in file name as **EX2**.

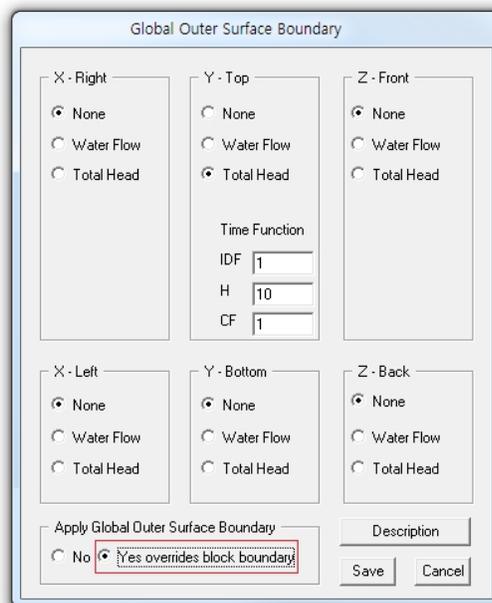


Figure 6.41 Global outer surface boundary

### Step 6: View Water Flow Boundary Code

1. Select **View → General** in PLOT-3D menu.
2. Select **Water Flow Boundary Code** and click **OK** in Figure 6.25.
3. Click **Show Numbers** toolbar as shown in Figure 6.26.
4. Water flow boundary codes are shown in Figure 6.42.

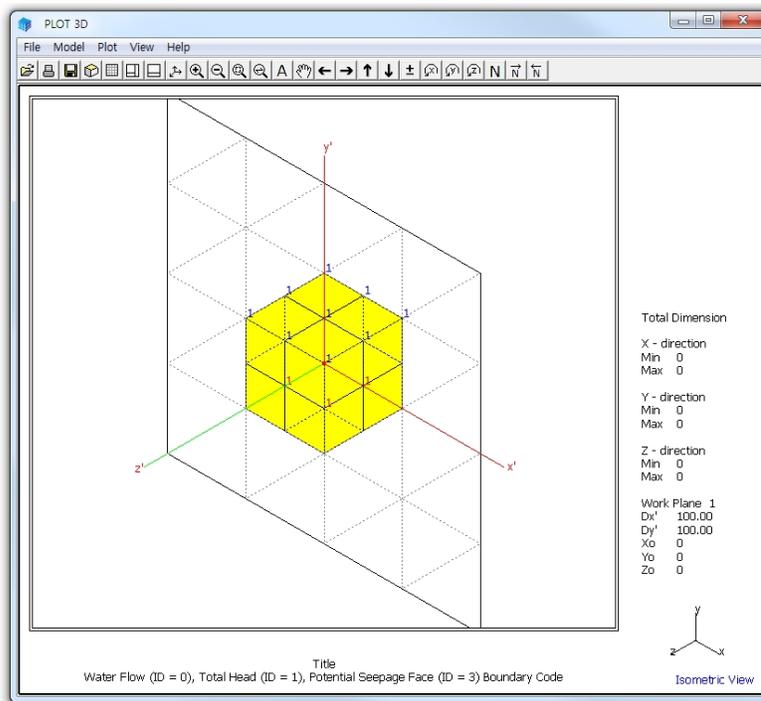


Figure 6.42 Water flow boundary codes on drawing board

### Step 7: Plot Finite Element Mesh

1. Click **Show F. E. Mesh** in Figure 6.37.
2. Rotate the finite element mesh as shown in Figure 6.43.

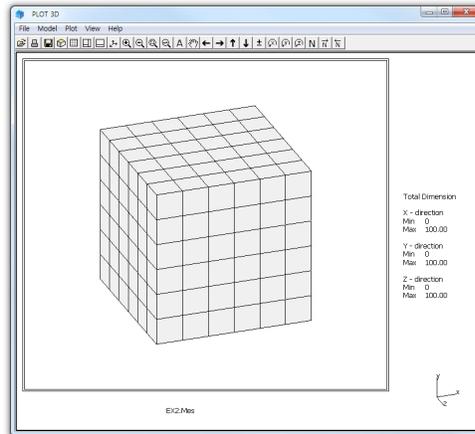


Figure 6.43 Finite element mesh

3. Follow same procedure to plot water flow boundary in Step 6.
4. Figure 6.44 shows water flow boundary code.

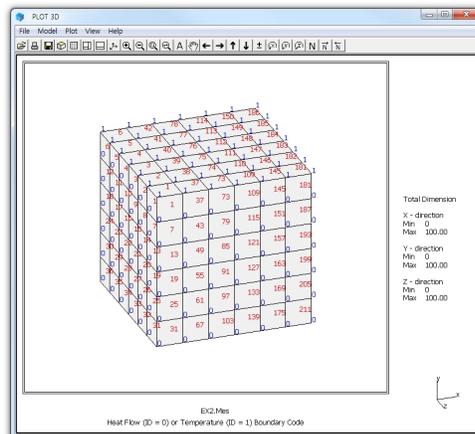


Figure 6.44 Water flow boundary codes

## 6.2.2 Part 2: Modifying Cube Earth Dam

Part 2 consists of the following three main steps:

1. Access block mesh generator (Open)
2. Modify element generation parameters
3. Plot finite element mesh

### Step 8: Access Block Mesh Generator (Open)

1. Access **Block Mesh Generator** by selecting the following menu items in **SMAP** (Figure 6.2):  
**Run → Mesh Generator → Block Mesh → Open**
2. Click **Browse** button in **Open Input File** dialog in Figure 6.45.
3. Select the input file **EX2.Meb** generated in Part 1 .



Figure 6.45 Open input file

**Step 9: Modify Element Generation Parameters**

1. Click **Block Editor** toolbar in Figure 6.12.
2. Modify **Alpha X**, **Alpha Y**, **Alpha Z** as in Figure 6.46.
3. Click **Reset**.
4. Click **Save**.

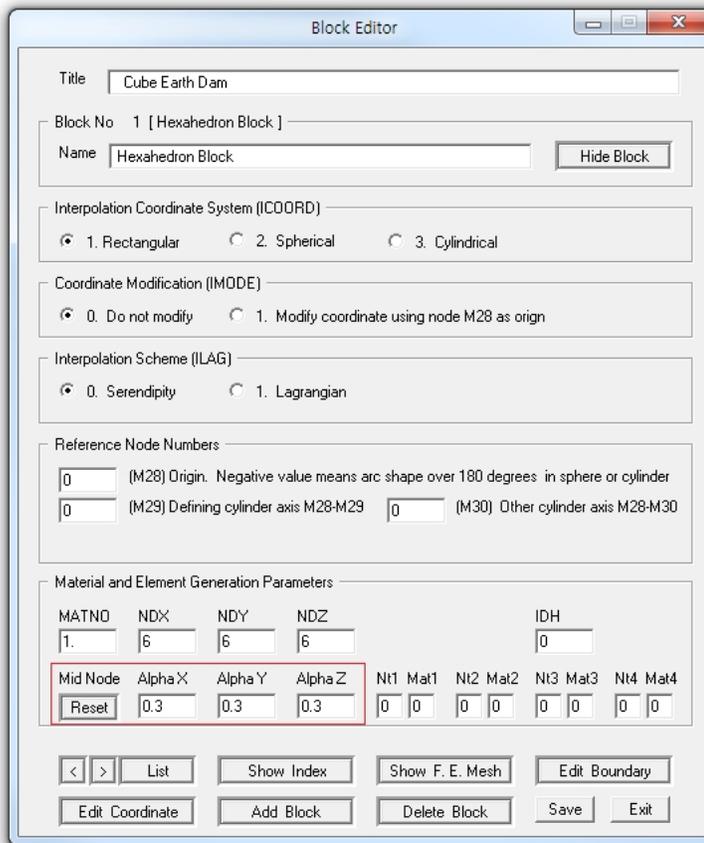


Figure 6.46 Block editor

## 6-32 Block Mesh Example

5. Click **Work Plane** toolbar and then click **Show Plane** button.
6. Click **Axis** toolbar in Figure 6.9.
7. Block mesh is shown in Figure 6.47.

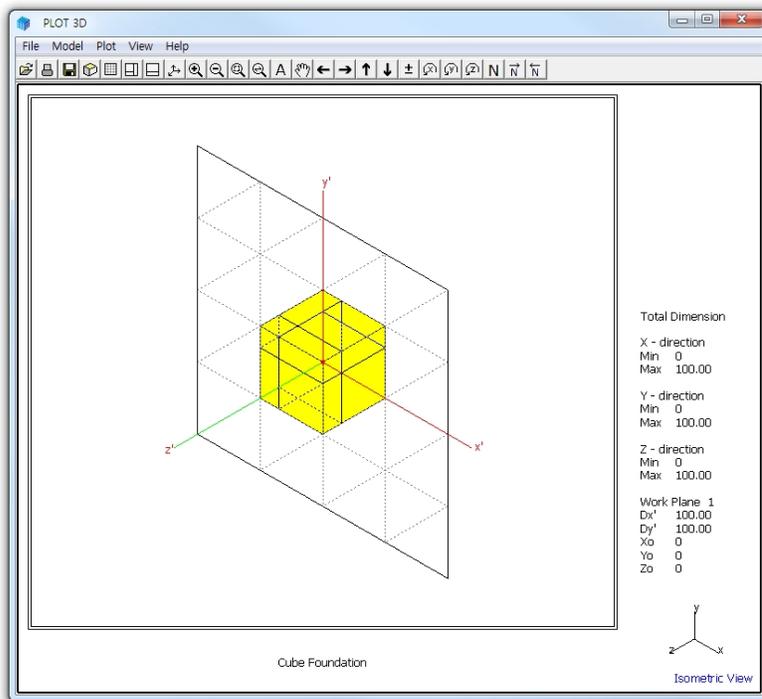


Figure 6.47 Block mesh on drawing board

**Step 7: Plot Finite Element Mesh**

1. Click **Show F. E. Mesh** in Figure 6.46.
2. Rotate the finite element mesh as shown in Figure 6.48.

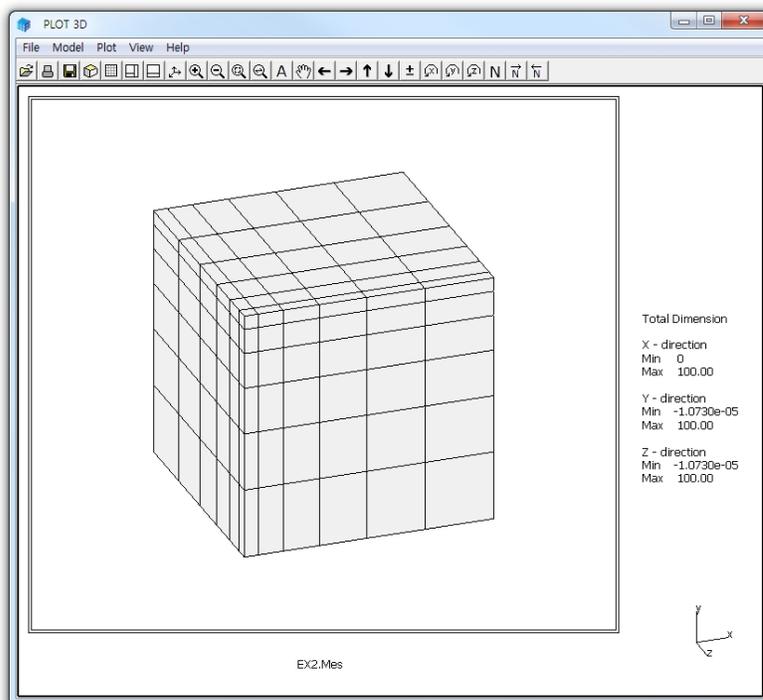


Figure 6.48 Finite element mesh



## **PRESMAP Example Problem**

PRESMAP menu includes six Pre-Processing programs: PRESMAP-2D, NATM-2D, CIRCLE-2D, PRESMAP-3D, CROSS-3D, GEN-3D, and PRESMAP-GP. These Pre-Processing programs are mainly used to generate Mesh File described in Section 4.3 of User's Manual. Refer to SMAP-W3 User's Manual:

- Section 5 for input parameters for PRESMAP programs.
- Section 3.2.2 for running PRESMAP programs.

### **7.1 PRESMAP-2D**

**PRESMAP-2D** includes **Model 1**, **2**, **3**, and **4**. **Model 1** is basic pre-processor which can be applied to model various types of problem geometry.

**Model 2** is the special pre-processor developed to model near-field around underground openings such as tunnels, culverts, etc. **Model 3** is the special pre-processor developed to model triangular and rectangular shape geometry. **Model 4** is the useful pre-processor to generate layered embankments having slope.

### **7.1.1 Model 1**

A typical underground tunnel is chosen here to illustrate mesh generations using [PRESMAP-2D Model 1](#) and [2](#). Figure 7.1 shows geological condition around tunnel consisting of four layers: weathered soil, weathered rock, soft rock, and hard rock. Figure 7.2 shows in detail tunnel cross section including shotcrete and rock bolt dimensions.

For convenience, the tunnel problem geometry is divided into three regions as shown in Figure 7.3; Core, Near-field, and Far-field regions. By symmetry, only right half of the tunnel geometry is considered.

[Model 1](#) is used to generate Core and Far-field region meshes. And [Model 2](#) is used to generate Near-field region mesh. Near-field region mesh generation will be explained in the next section. And assembly of Core, Near-field, and Far-field regions will be explained in ADDRGN-2D Example Problems in Section 8.1.

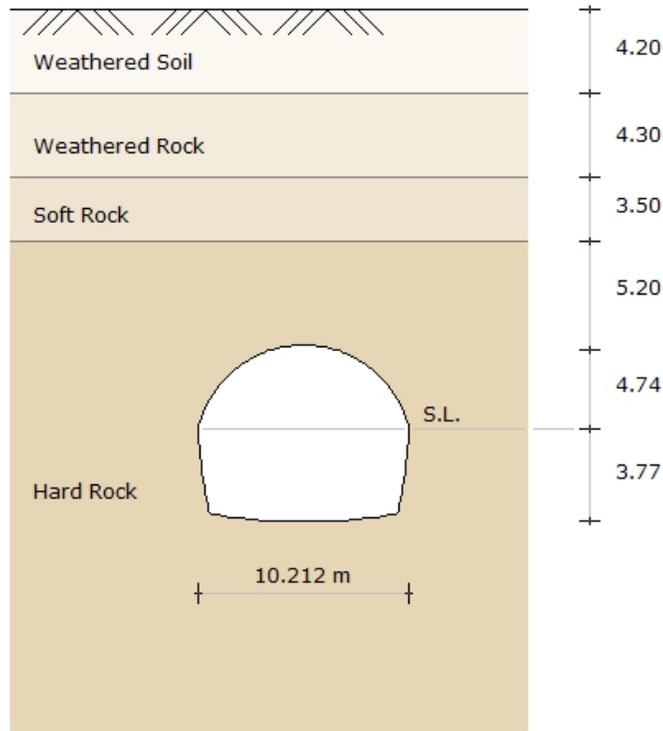
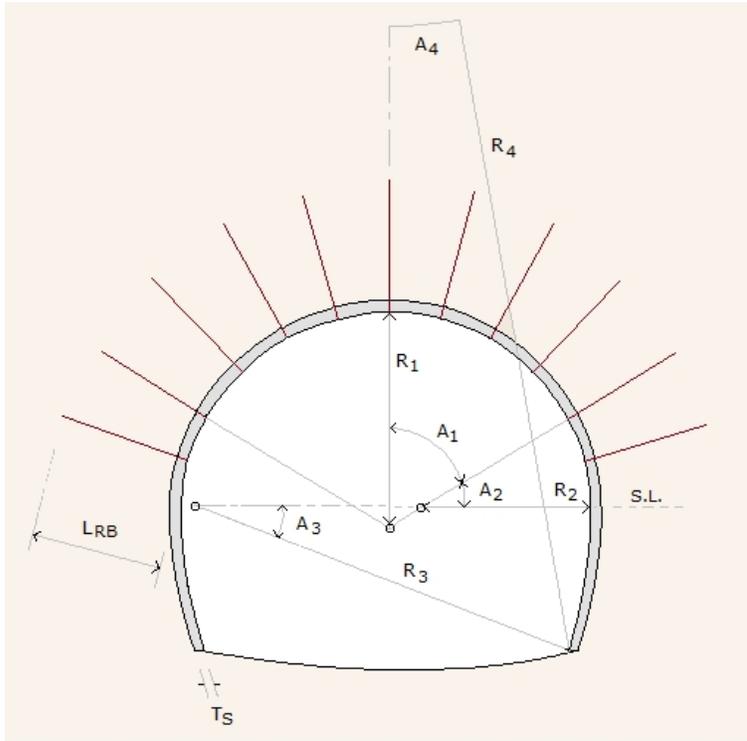


Figure 7.1 Geological condition



$R_1 = 5.24 \text{ m}$      $A_1 = 60^\circ$   
 $R_2 = 4.24 \text{ m}$      $A_2 = 30^\circ$   
 $R_3 = 9.86 \text{ m}$      $A_3 = 19.781^\circ$   
 $R_4 = 23.86 \text{ m}$

Number of Rock Bolts ( NUMRB)    = 11  
 Length of Rock Bolts ( LRB)        = 3.0 m  
 Spacing of Rock Bolts ( TSPACING) = 1.2 m  
 Thickness of Shotcrete ( TS)         = 15 Cm  
 Thickness of Liner (TL)               = 30 Cm  
 Reinforcing Bar Area (ASI)          = 22 Cm<sup>2</sup>  
 Reinforcing Bar Area (ASO)         = 22 Cm<sup>2</sup>

Figure 7.2 PD-2 tunnel section detail

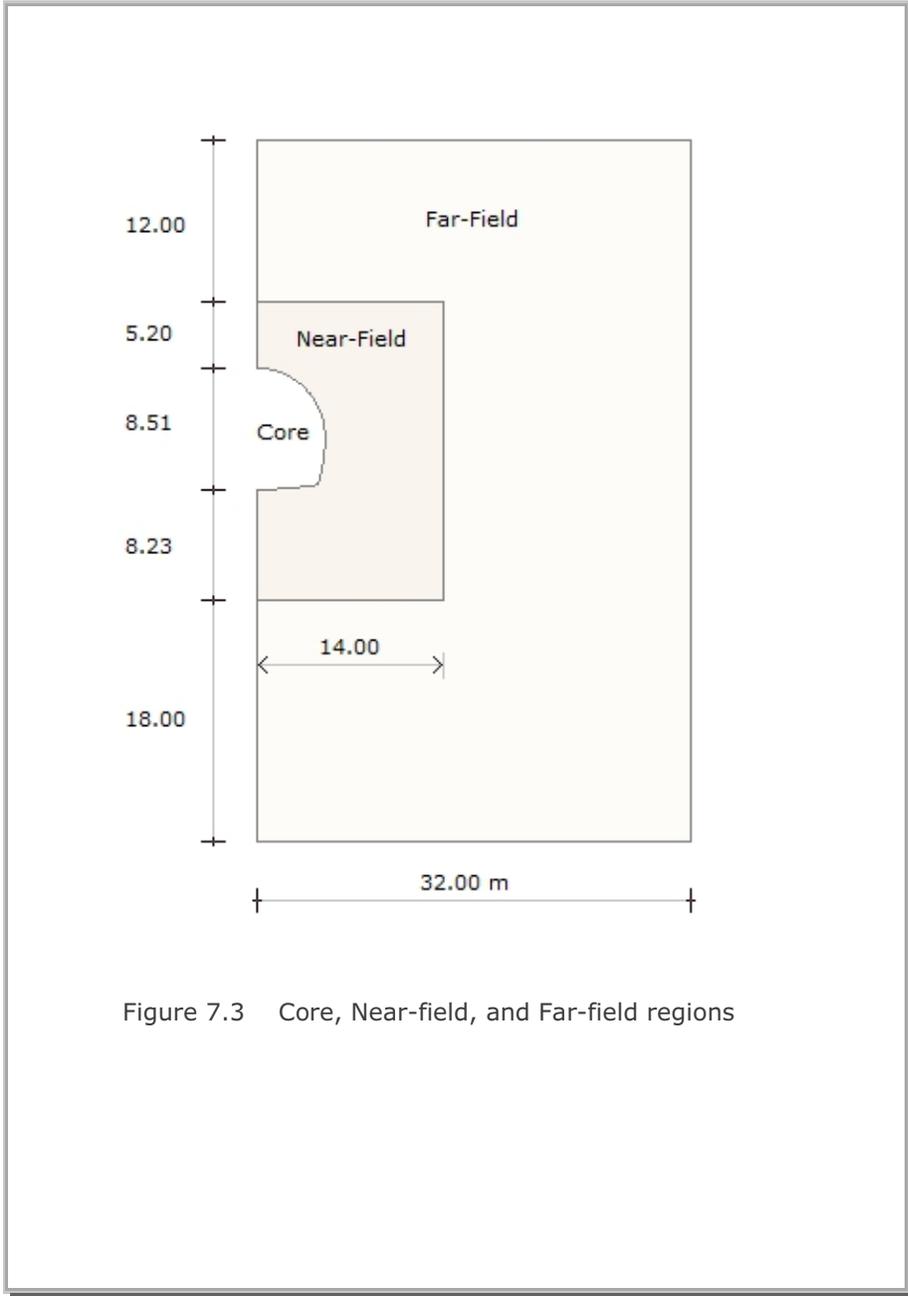


Figure 7.3 Core, Near-field, and Far-field regions

### 7.1.1.1 Core Region Mesh Generation

Figure 7.4 shows the block diagram for the Core region. Three blocks are used in the horizontal direction (NBX=3) and four blocks in the vertical direction (NBY=4). Block numbers should be in order from top to bottom and left to right. Top 9 blocks (Block numbers 1,2,3,5,6,7,9,10, and 11) represent upper half of tunnel core to be excavated first and bottom 3 blocks (Block numbers 4,8, and 12) represent lower half of tunnel core to be excavated later.

Each block can be consisted of 4 to 9 block nodes depending on whether you can include side and center block nodes. For those blocks facing the tunnel wall of the Core region, side block nodes are included to form the curve. Note that when the side block node is not specified, the straight line will be formed along that side.

Block index should be specified in counterclockwise. For example, the index of Block 4 can be written as  $I_1=11$ ,  $I_2=4$ ,  $I_3=5$ ,  $I_4=12$ ,  $M_5=0$ ,  $M_6=0$ ,  $M_7=7$ ,  $M_8=0$ ,  $M_9=0$ . Next, each block is further divided into elements. For example, Block 4 has 2 elements in the horizontal direction (NDX=2) and 6 elements in the vertical direction (NDY=6). It should be noted that to be compatible, the same number of divisions be specified along the two adjacent blocks. For example, Blocks 4, 8, and 12 have 6 elements in the vertical direction so that the generated elements can share the same nodal points along the boundaries of these blocks.

Since the tunnel is symmetry about  $y$  axis, the boundary condition along the  $y$  axis is specified as the roller which allows the displacement in the  $y$  direction and the boundary condition at all other nodes is specified to be free. And material number.4 representing hard rock is specified for all blocks since the Core region belongs to the hard rock layer as shown in Figure 7.1.

Table 7.1 shows the listing of input file, [CORE.Rgn](#), which has been prepared according to the [PRESMAP-2D Model 1](#) in Section 7.2.1 of User's Manual. Note that the format of the [PRESMAP-2D](#) output file is the same as that of Mesh File in SMAP-W2 User's Manual. Graphical outputs are shown in Figure 7.5.

Table 7.1 Listing of input file CORE.Rgn

```
* INPUT DATA FOR PRESMAP-2D MODEL 1
* CARD 1.1
  PD-2 CORE REGION GENERATION
* CARD 1.2
* IP
  0
* CARD 1.3
* NBLOCK  NBNODE  NSNEL  CMFAC  TEMPI
   12      30      1      1.0   10.
* CARD 1.4
* NBX  NBY  MIDX  MIDY  NF  NSNODE
   3    4    0    0    1    1
* CARD 2.1
* NODE  X      Y
   1    0.0    4.74
   2    0.0    3.16
   3    0.0    1.58
   4    0.0    0.0
   5    0.0   -3.77
   6    0.684  4.695
   7    0.76   -3.7579
   8    1.356  4.562
   9    1.488  2.819
  10    1.594  1.425
  11    1.702  0.0
  12    1.517 -3.722
  13    2.005  4.341
  14    2.273 -3.662
  15    2.62   4.038
  16    2.9204 2.4907
  17    3.157  1.273
  18    3.404  0.0
  19    3.025 -3.577
  20    3.19   3.66
  21    3.776 -3.47
  22    3.705  3.205
  23    4.157  2.69
  24    4.538  2.12
  25    4.783  1.623
  26    4.962  1.097
  27    5.07   0.5534
  28    5.106  0.0
  29    4.96  -1.693
  30    4.524 -3.337
```

## 7-8 PRESMAP-2D Example Problem

```
* =====  
* CARD 3.1  
* BLNAME  
* BLOCK 1  
* CARD 3.2  
* IBLNO  
* 1  
* CARD 3.3  
* I1 I2 I3 I4 M5 M6 M7 M8 M9  
* 8 1 2 9 6 0 0 0 0  
* CARD 3.5  
* MATNO NDX NDY IDH  
* 4 2 2 0  
* CARD 3.6  
* NFSIDE  
* 0  
* =====  
* BLOCK 2  
* 2  
* 9 2 3 10 0 0 0 0 0  
* 4 2 2 0  
* 0  
* =====  
* BLOCK 3  
* 3  
* 10 3 4 11 0 0 0 0 0  
* 4 2 2 0  
* 0  
* =====  
* BLOCK 4  
* 4 3.337  
* 11 4 5 12 0 0 7 0 0  
* 4 2 6 0  
* 0  
* =====  
* BLOCK 5  
* 5  
* 15 8 9 16 13 0 0 0 0  
* 4 2 2 0  
* 0
```

```

* =====
BLOCK 6
6
16 9 10 17 0 0 0 0 0
4 2 2 0
0
* =====
BLOCK 7
7
17 10 11 18 0 0 0 0 0
4 2 2 0
0
* =====
BLOCK 6
6
16 9 10 17 0 0 0 0 0
4 2 2 0
0
* =====
BLOCK 7
7
17 10 11 18 0 0 0 0 0
12 12 12 12 12 12 12 12 12
4 2 2 0
0
* =====
BLOCK 8
8
18 11 12 19 0 0 14 0 0
4 2 6 0
0
* =====
BLOCK 9
9
22 15 16 24 20 0 0 23 0
4 2 2 0
0

```

**7-10** PRESMAP-2D Example Problem

---

```
* =====  
BLOCK 10  
10  
24 16 17 26 0 0 0 25 0  
4 2 2 0  
0  
* =====  
BLOCK 11  
11  
26 17 18 28 0 0 0 27 0  
4 2 2 0  
0  
* =====  
BLOCK 12  
12  
28 18 19 30 0 0 21 29 0  
4 2 6 0  
0  
* =====
```

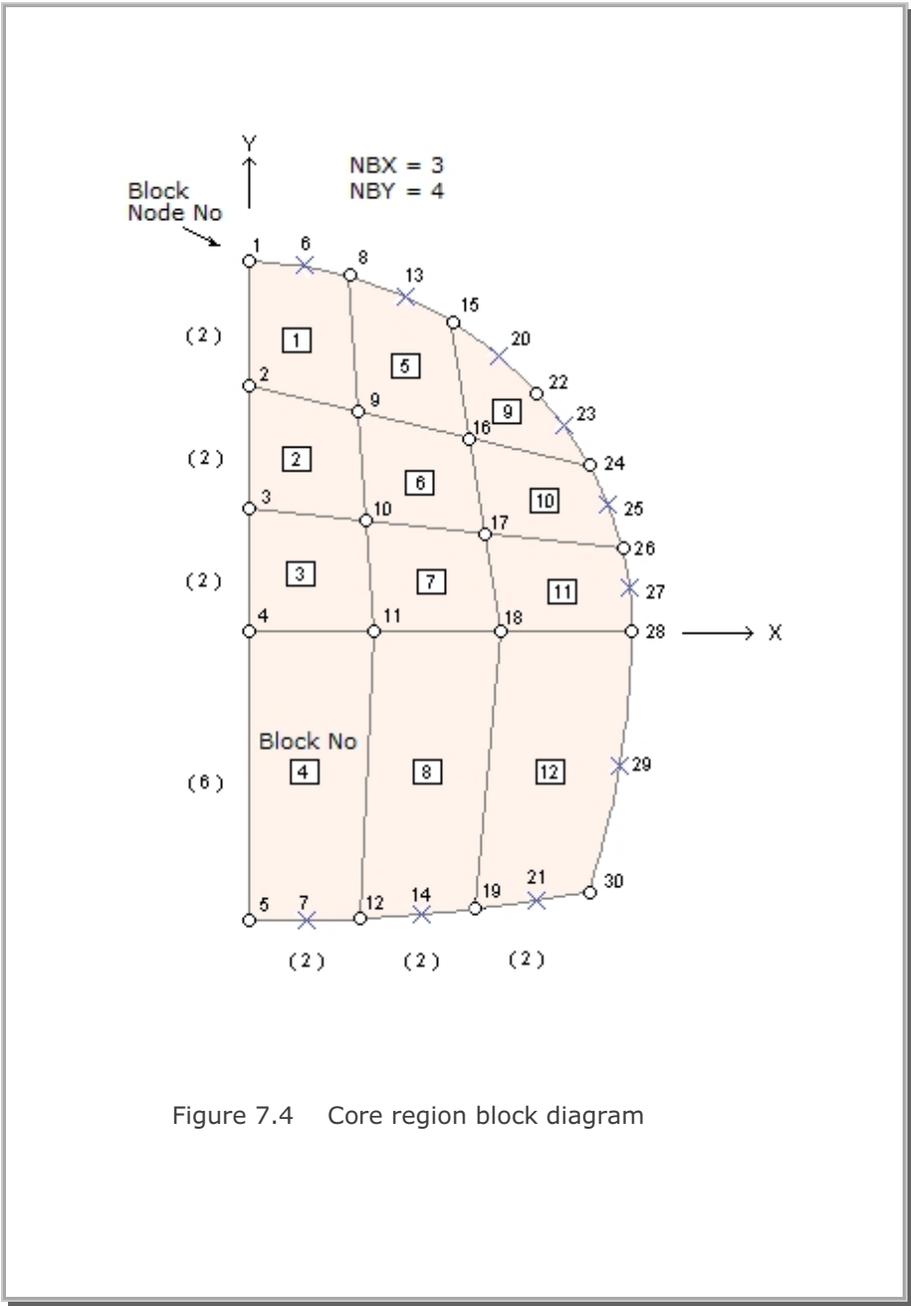


Figure 7.4 Core region block diagram

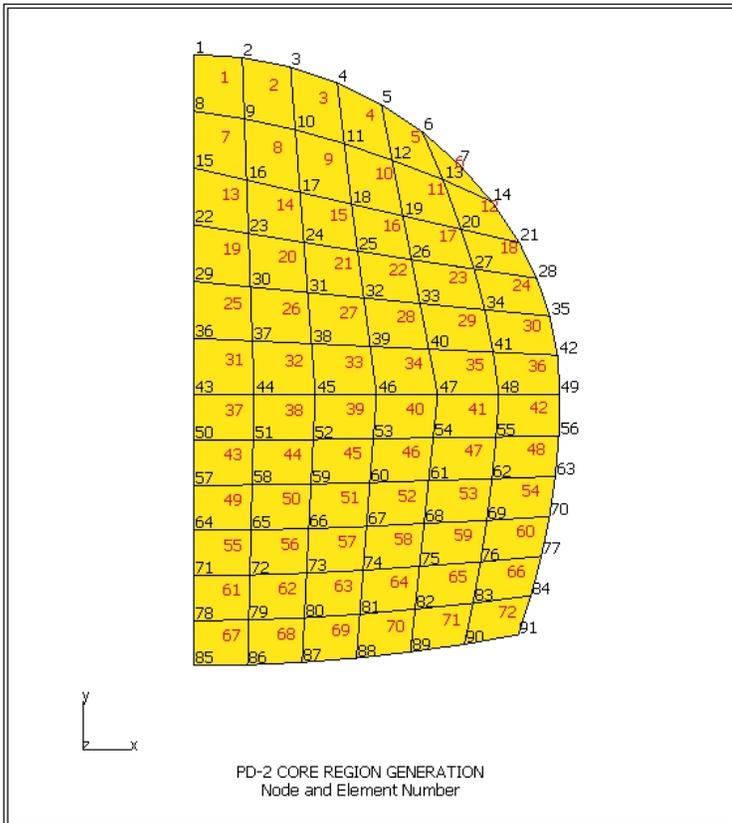


Figure 7.5 Generated element and node numbers for Core region

### 7.1.1.2 Far-Field Region Mesh Generation

Figure 7.6 shows the block diagram for the Far-field region. Two blocks are used in the horizontal direction ( $NBX=2$ ) and 6 blocks in the vertical direction ( $NBY=6$ ). Block numbers 1 and 7 represent weathered soil ( $MATNO=1$ ). Block numbers 2 and 8 represent weathered rock ( $MATNO=2$ ). Block numbers 3 and 9 represent soft rock ( $MATNO=3$ ). And the rest of blocks represent hard rock ( $MATNO=4$ ) except Block numbers 4 and 5 ( $MATNO=0$ ). Note that Block numbers 4 and 5 are void blocks. Elements in this void blocks are not generated in Far-field region, but will be generated in Core and Near-field regions.

You can specify the index of each block as for Core region. Side block nodes are used here to make element sizes bigger as the elements are away from the tunnel core. To simulate plane strain condition at the remote boundary, boundary conditions for the left, right, and bottom are specified as the roller.

Table 7.2 shows the listing of input file, [FAR.Rgn](#), which has been prepared according to the [PRESMAP-2D Model 1](#) in Section 7.2.1 of User's Manual. Generated element and node numbers are shown in Figure 7.7. Note that the Far-field element number starts from 337, considering that there are 336 elements in Core and Near-field regions.

Table 7.2 Listing of input file FAR.Rgn

```

* INPUT DATA FOR PRESMAP-2D MODEL 1
* CARD 1.1
  PD-2 FAR-FIELD REGION GENERATION
* CARD 1.2
* IP
  0
* CARD 1.3
* NBLOCK  NBNODE  NSNEL  CMFAC  TEMPI
  12      31      337    1.0    10.
* CARD 1.4
* NBX  NBY  MIDX  MIDY  NF  NSNODE
  2    6    0     0    1    1
* CARD 2.1
* NODE  X      Y
  1     0.0    21.94
  2     0.0    17.74
  3     0.0    13.44
  4     0.0     9.94
  5     0.0     0.0
  6     0.0   -12.0
  7     0.0   -19.2
  8     0.0   -30.0
  9    14.0    21.94
 10    14.0    17.74
 11    14.0    13.44
 12    14.0     9.94
 13    14.0     0.0
 14    14.0   -12.0
 15    14.0   -19.2
 16    14.0   -30.0
 17    21.2    21.94
 18    21.2    17.74
 19    21.2    13.44
 20    21.2     9.94
 21    21.2     0.0
 22    21.2   -12.0
 23    21.2   -30.0
 24    32.0    21.94
 25    32.0    17.74
 26    32.0    13.44
 27    32.0     9.94
 28    32.0     0.0
 29    32.0   -12.0
 30    32.0   -19.2
 31    32.0   -30.0

```

```

* =====
* CARD 3.1
* BLNAME
  BLOCK 1
* CARD 3.2
* IBLNO
  1
* CARD 3.3
* I1 I2 I3 I4 M5 M6 M7 M8 M9
  9 1 2 10 0 0 0 0 0
* CARD 3.5
* MATNO NDX NDY IDH
  1 6 1 0
* CARD 3.6
* NFSIDE
  0
* =====
  BLOCK 2
  2
  10 2 3 11 0 0 0 0 0
  2 6 1 0
  0
* =====
  BLOCK 3
  3
  11 3 4 12 0 0 0 0 0
  3 6 2 0
  0
* =====
  BLOCK 4
  4
  12 4 5 13 0 0 0 0 0
  0 6 6 0
  0
* =====
  BLOCK 5
  5
  13 5 6 14 0 0 0 0 0
  0 6 6 0
  0

```

## 7-16 PRESMAP-2D Example Problem

```
* =====  
BLOCK 6  
6  
14 6 8 16 0 7 0 15 0  
4 6 4 0  
0  
* =====  
BLOCK 7  
7  
24 9 10 25 17 0 18 0 0  
1 4 1 0  
0  
* =====  
BLOCK 8  
8  
25 10 11 26 18 0 19 0 0  
2 4 1 0  
0  
* =====  
BLOCK 9  
9  
26 11 12 27 19 0 20 0 0  
3 4 2 0  
0  
* =====  
BLOCK 10  
10  
27 12 13 28 20 0 21 0 0  
4 4 6 0  
0  
* =====  
BLOCK 11  
11  
28 13 14 29 21 0 22 0 0  
4 4 6 0  
0
```

```
* =====  
BLOCK 12  
12  
29 14 16 31 22 15 23 30 0  
4 4 4 0  
0  
* =====  
* END OF DATA
```

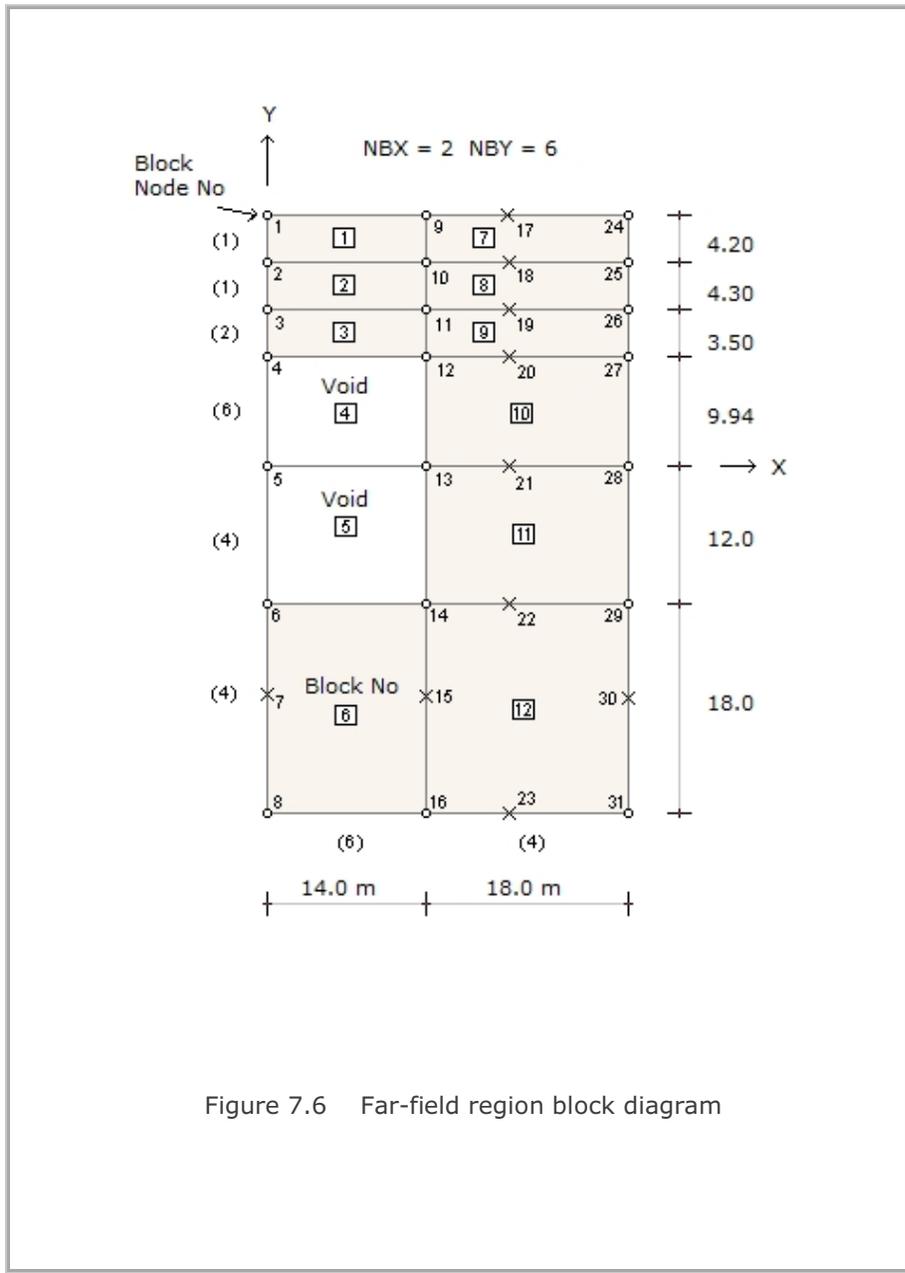
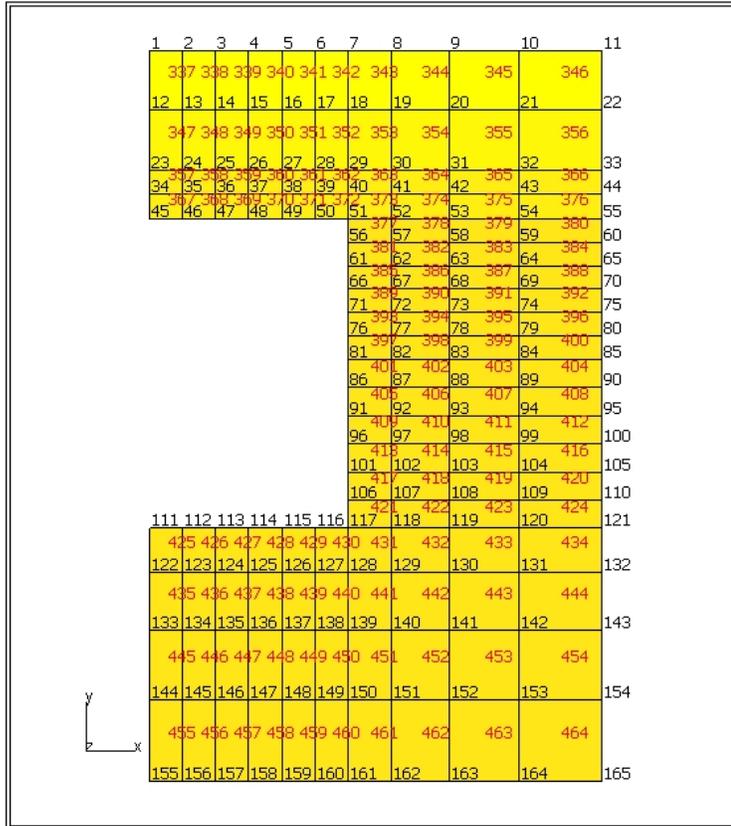


Figure 7.6 Far-field region block diagram



PD-2 FAR-FIELD REGION GENERATION  
Node and Element Number

Figure 7.7 Generated element and node numbers for Far-field region

### **7.1.2 Model 2**

**Model 2** is the special pre-processor developed to model Near-field region around the underground openings. The Near-field region shown in Figure 7.3 is taken here as an example problem.

As shown in Figure 7.8, eight subregions are used to construct the Near-field region. And each subregion consists of three blocks. Then each block is further divided in radial and tangential directions. For example, Block number 5 in Subregion 2 has 5 elements in radial direction and 6 elements in the tangential direction. Note that element sizes in third block increase gradually in radial direction. Parameters specific to each subregion are tabulated in Table 7.3.

Table 7.4 shows the listing of input file, **NEAR.Rgn**, which has been prepared according to the **PRESMAP-2D Model 2** in Section 7.2.2 of User's Manual. Generated element mesh is shown in Figure 7.9.

Table 7.3 Parameters specific in Near-field region

NSUBR = 8      NDRF = 2      NDRS = 5    NDRT = 4  
 DRF = 0.15 m    DRS = 2.85 m

Subregion	ISBTYPE	LSFTYPE	NSEG
1	1	1	6
2	1	1	6
3	0	1	2
4	0	1	2
5	0	1	2
6	0	1	2
7	0	1	2
8	0	1	2

Global block numbers are in order from surface

to outer edge and counterclockwise.

Local block numbers in each subregion are in order from surface to outer edge.

Example : In Subregion 2,  
 First block = 4 , Second block = 5, Third block = 6

Table 7.4 Listing of input file NEAR.Rgn

```
* INPUT DATA FOR PRESMAP-2D MODEL 2
* CARD 1.1
  PD-2 NEAR-FIELD MESH GENERATION
* CARD 1.2
* IP
  0
* CARD 1.3
* NSNEL  NSNODE  NF  CMFAC  TEMPI
  73      67      1  1.0    10.
* CARD 1.4
* NSURB  NDRF  NDRS  NDRT  DRF  DRS
  8      2      5    4    0.15  2.85
* =====
* CARD 2.1
* SUBNAME
  SUBREGION 1
* CARD 2.2
* ISUBNO
  1
* CARD 2.3
* ISBTYPE  LSFTYPE  NSEC
  1        1        6
* CARD 2.4.2 (LSFTYPE = 1)
* R      Xo  Yo  TA  TB
  23.86  0.0  20.09  270.  280.93
* (ISBTYPE = 1)
* CARD 2.5.3
* Xc  Yc  Xd  Yd
  0.0  -12.  14.0  -12.
* CARD 2.7
* MATNO1  IDH1
  4      0
* MATNO2  IDH2
  4      0
* MATNO3  IDH3
  4      0
* CARD
* NFSIDE
  0
```

```
* =====  
SUBREGION 2  
2  
1 1 6  
9.86 -4.754 0.0 340.22 360.  
14.0 -12. 14.0 0.0  
4 0  
4 0  
4 0  
0  
* =====  
SUBREGION 3  
3  
0 1 2  
4.24 0.866 0.0 0.0 15.0  
1  
14.0  
0  
14.0 3.31  
4 0  
4 0  
4 0  
0  
* =====  
SUBREGION 4  
4  
0 1 2  
4.24 0.866 0.0 15.0 30.0  
0  
14.0 3.31  
0  
14.0 6.63  
4 0  
4 0  
4 0  
0
```

**7-24** PRESMAP-2D Example Problem

---

```
* =====
SUBREGION 5
5
0 1 2
5.24 0.0 -0.5 30.0 45.0
0
14.0 6.63
0
14.0 9.94
4 0
4 0
4 0
0
* =====
SUBREGION 6
6
0 1 2
5.24 0.0 -0.5 45.0 60.0
0
14.0 9.94
0
9.33 9.94
4 0
4 0
4 0
0
* =====
SUBREGION 7
7
0 1 2
5.24 0.0 -0.5 60. 75.0
0
9.33 9.94
0
4.67 9.94
4 0
4 0
4 0
0
```

```
* =====  
SUBREGION 8  
8  
0 1 2  
5.24 0.0 -0.5 75.0 90.0  
0  
4.67 9.94  
0  
0.0 9.94  
4 0  
4 0  
4 0  
0  
* =====
```

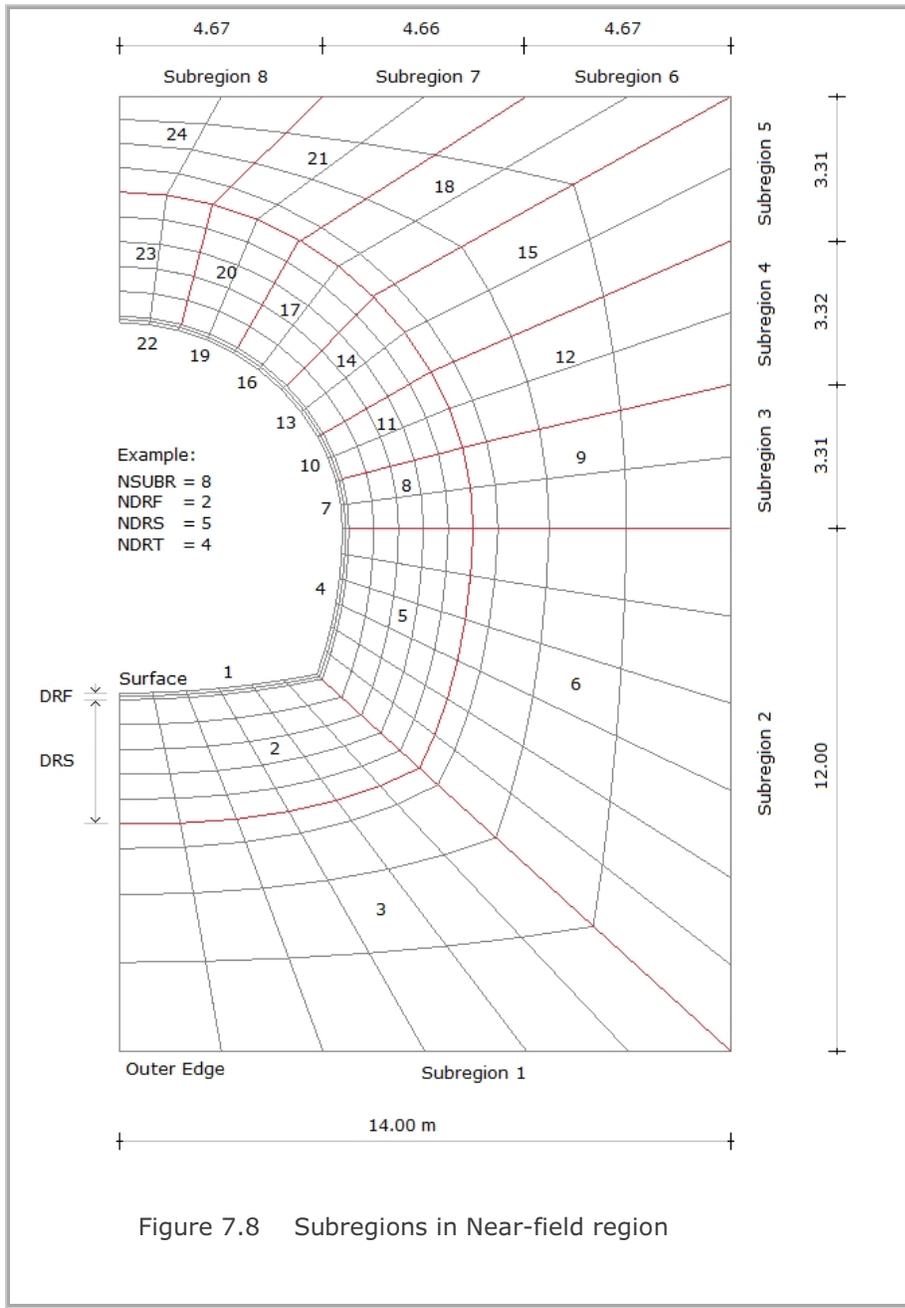
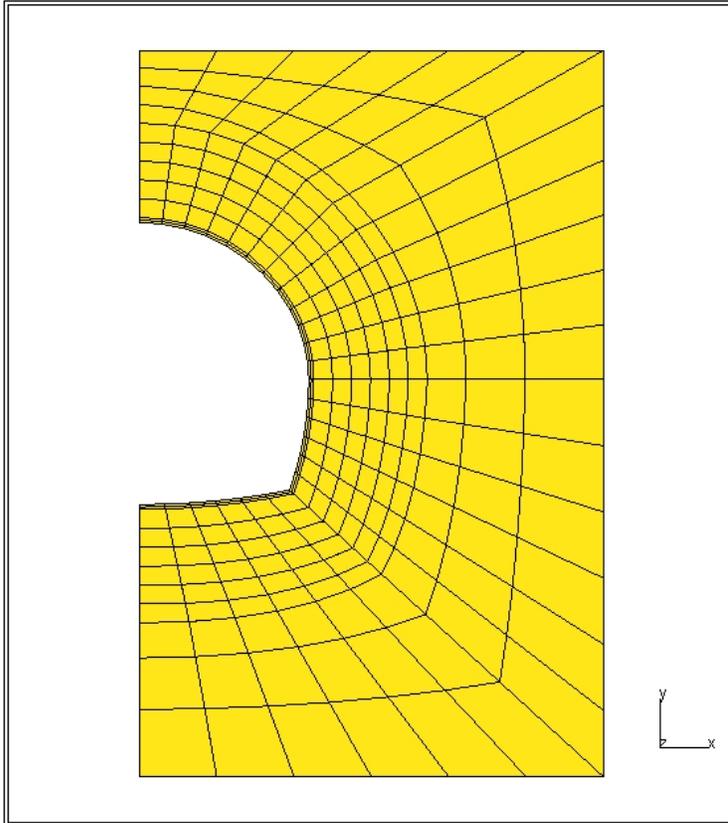


Figure 7.8 Subregions in Near-field region



PD-2 NEAR-FIELD MESH GENERATION

Figure 7.9 Generated mesh for Near-field region

### **7.1.3 Model 3**

**Model 3** is a useful pre-processor to generate triangular or rectangular meshes. It is much easier to use compared to **Models 1** and **2**. But you have to specify the boundary codes manually.

Figure 7.10 shows block diagram for **Model 3** example problem. Block numbers 1 to 5 are 4 x 4 rectangular shape and Block number 6 is the 9-element triangular shape.

Table 7.5 shows the listing of input file, **GM3.Rgn**, which has been prepared according to the **PRESMAP-2D Model 3** in Section 7.2.3 of User's Manual. Generated element and node numbers are shown in Figure 7.11.

**Table 7.5 Listing of input file GM3.Rgn**

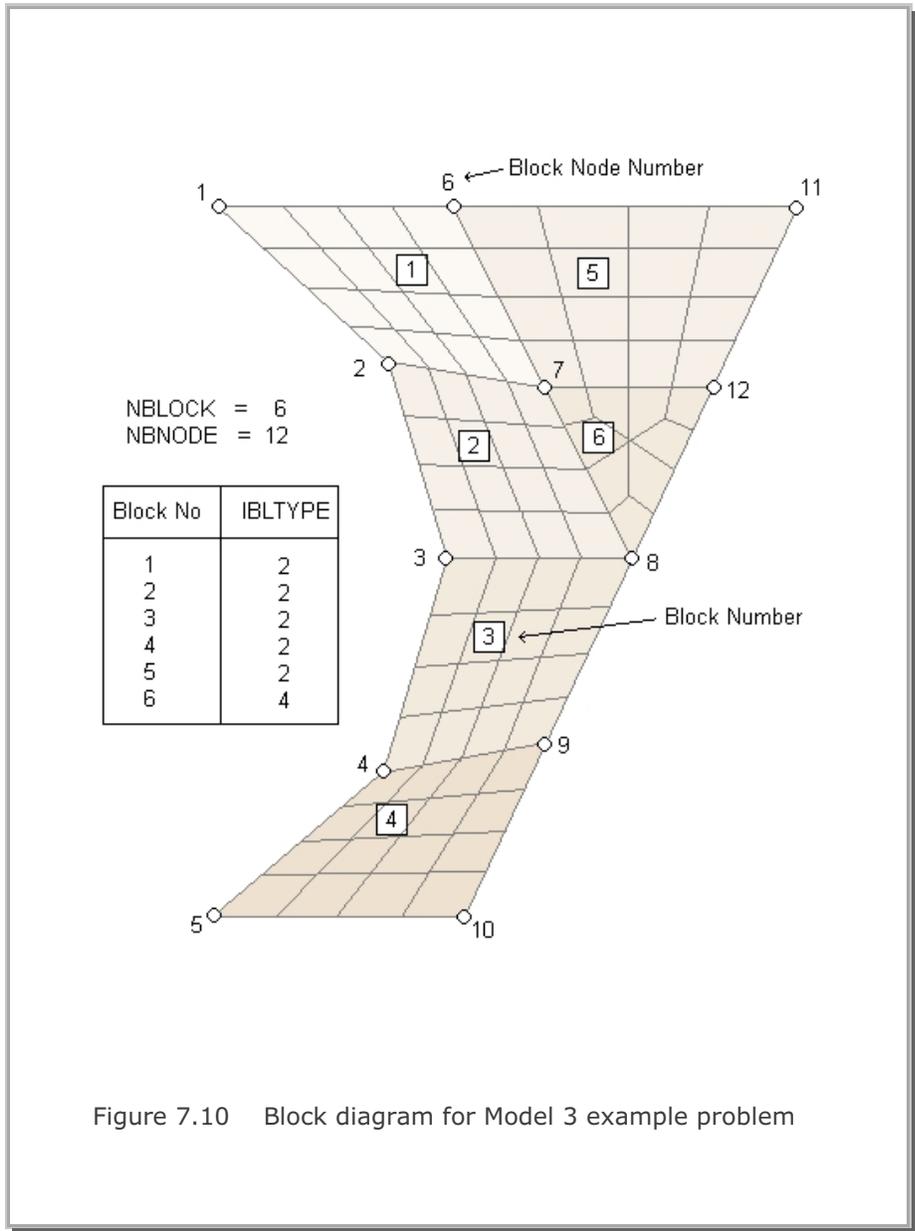
```

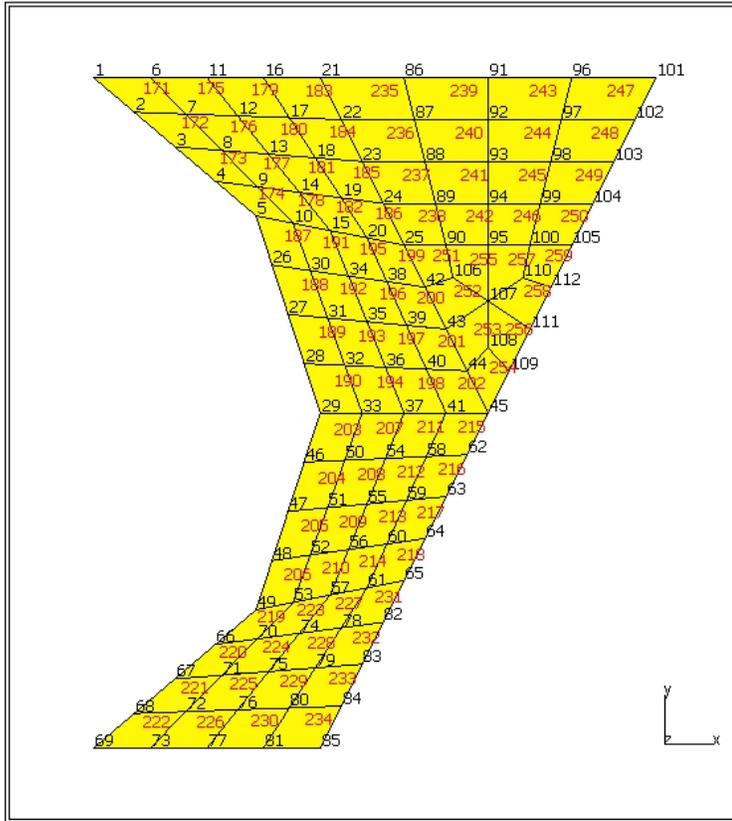
* INPUT DATA FOR PRESMAP-2D MODEL 3
* CARD 1.1
  MESH GENERATION SURROUNDING PIPE ( GM3 )
* CARD 1.2
* IP
  0
* CARD 1.3
* NBLOCK  NBNODE  NSNEL  NSNODE  CMFAC
      6      12      171      1      1.0
* CARD 2.1
* NODE      X          Y
  1  .324920E+02  .100000E+03
  2  .809020E+02  .587790E+02
  3  .100000E+03  .000000E+00
  4  .809020E+02  -.587790E+02
  5  .324920E+02  -.100000E+03
  6  100.         100.
  7  125.         50.
  8  150.         0.
  9  125.        -50.
 10  100.        -100.
 11  200.         100.
 12  175.         50.
* =====
* CARD 3.1
* =====
* IBLNO  IBLTYPE  MATNO  IDH
      1      2      2      0
* FOR IBLTYPE = 2
* I1 I2 I3 I4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16
  6  1  2  7  0  0  0  0  0  0  0  0  0  0  0  0
* =====
* IBLNO  IBLTYPE  MATNO  IDH
      2      2      2      0
* FOR IBLTYPE = 2
* I1 I2 I3 I4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16
  7  2  3  8  0  0  0  0  0  0  0  0  0  0  0  0
* =====
* IBLNO  IBLTYPE  MATNO  IDH
      3      2      2      0
* FOR IBLTYPE = 2
* I1 I2 I3 I4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16
  8  3  4  9  0  0  0  0  0  0  0  0  0  0  0  0

```

## 7-30 PRESMA2D Example Problem

```
* =====  
* IBLNO  IBLTYPE  MATNO  IDH  
*   4      2      2      0  
* FOR IBLTYPE = 2  
* I1 I2 I3 I4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16  
*   9  4  5 10  0  0  0  0  0  0  0  0  0  0  0  0  
* =====  
* IBLNO  IBLTYPE  MATNO  IDH  
*   5      2      2      0  
* FOR IBLTYPE = 2  
* I1 I2 I3 I4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16  
*  11  6  7 12  0  0  0  0  0  0  0  0  0  0  0  0  
* =====  
* IBLNO  IBLTYPE  MATNO  IDH  
*   6      4      2      0  
* FOR IBLTYPE = 2  
* I1 I2 I3 M4 M5 M6 M7 M8 M9 M10 M11 M12  
*   7  8 12  0  0  0  0  0  0  0  0  0  
* =====
```





MESH GENERATION SURROUNDING PIPE ( GM3 )  
Node and Element Number

Figure 7.11 Generated element and node numbers for Model 3 example problem

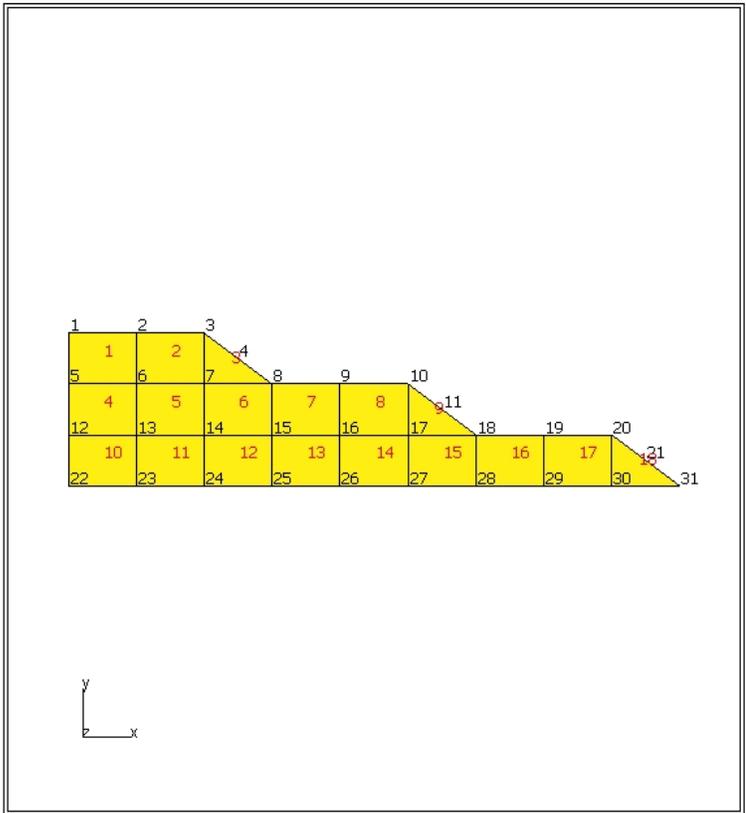
### **7.1.4 Model 4**

**Model 4** is a useful pre-processor to generate horizontally layered dams or embankments. It is easy to use but the boundary codes should be specified manually.

As **Model 4** example problem, an embankment with 3 layers is considered. Table 7.6 shows the listing of input file, **GM4.Rgn**, which has been prepared according to the **PRESMAP-2D Model 4** in Section 7.2.4 of User's Manual. Generated element and node numbers are shown in Figure 7.12.

**Table 7.6** Listing of input file GM4.Rgn

```
* CARD 1.1
* TITLE
  EXAMPLE PROBLEM FOR PRESMAP-2D MODEL 4
* CARD 1.2
* NLAYER  NDIV  ITRANGL
   3       3     1
* CARD 1.3
* NSNEL   NSNODE  CMFAC
   1       1     1.0
* CARD 2.1
* XB1   YB1   YB2   XB2
  0.0   3.0   0.0   12.
* CARD 3.1
* MATNO  IDH
   3     0
* END OF DATA
```



EXAMPLE PROBLEM FOR PRESMAP-2D MODEL4  
Node and Element Number

Figure 7.12 Generated element and node numbers for Model 4 example problem

## 7.2 NATM-2D

NATM-2D is the special pre-processing program to generate automatically two-dimensional finite element meshes and boundary conditions for NATM tunnels. NATM-2D has four different models:

Model 1	Single Tunnel (Half Section)
Model 2	Single Tunnel (Full Section)
Model 3	Two Tunnel (Symmetric Section)
Model 4	Two Tunnel (Unsymmetric Section)

Once you have executed NATM-2D, you will obtain following files:

<u>Output File</u>	Mesh File including all elements (Continuum, Beam, and Truss). <u>Output File</u> is the user specified name.
BEAM.Dat	Mesh File including only beam elements.
TRUSS.Dat	Mesh File including only truss elements.
AD.Dat	Card Group 8 in Main File representing default element activities for upper and lower parts of Core, Shotcrete, and Rock Bolt including Joint and Lining elements.
LINING.Dat	Mesh File for Beam-Spring Lining Analysis. This file will be generated only for ILNCOUPL=1.

A typical PD2 tunnel shape is chosen here to illustrate mesh generation using NATM-2D as shown in Figure 7.13. For each model, we will present:

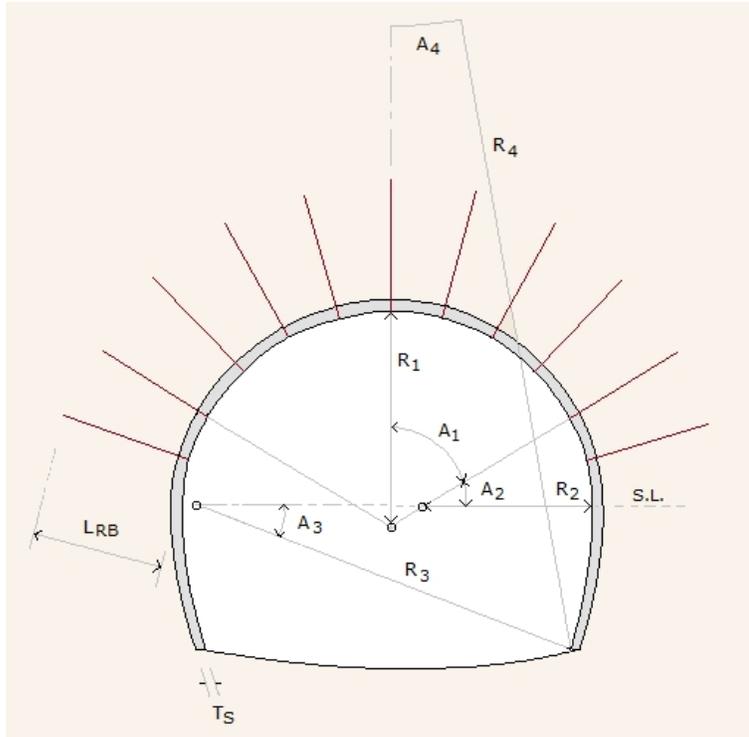
- Listing of input file
- Schematic tunnel section view
- Graphical output of finite element mesh

**Table 7.7 Listing of input file PD2-1.Dat**

```

* CARD 1.1
* TITLE
  NATM-2D MODEL 1 EXAMPLE PROBLEM
* CARD 1.2
* IUNIT
  2
* CARD 1.3
* MODEL  IGEN  IEXMESH  ILNCOUPL
  1      0      0          0
* CARD 2.1
* HT      HL      W      DELTAX  DELTAX  NDYMAX
  21.94  30.    20.    2.0     2.0     40
* CARD 3.1
* NLAYER
  4
* CARD 3.2
* LAYERNO  H      IDH
  1         4.2   0
  2         4.3   0
  3         3.5   0
  4        39.94  0
* CARD 4.1
* R1      A1      R2      A2  R3      A3      R4      GR      GA
  5.24   60.    4.24   30.  9.86   19.781  23.86  1.0   0.5
* CARD 4.2
* INVSHOT  TS
  0         0.3
* CARD 4.3
* NUMRB   LRB      LSPACING  TSPACING  NSRB
  11      3.0     0.8       1.2       2
* CARD 5.1
* LDTYPE  DGW      GAMAW
  0       2.0     1.0
* END OF DATA

```

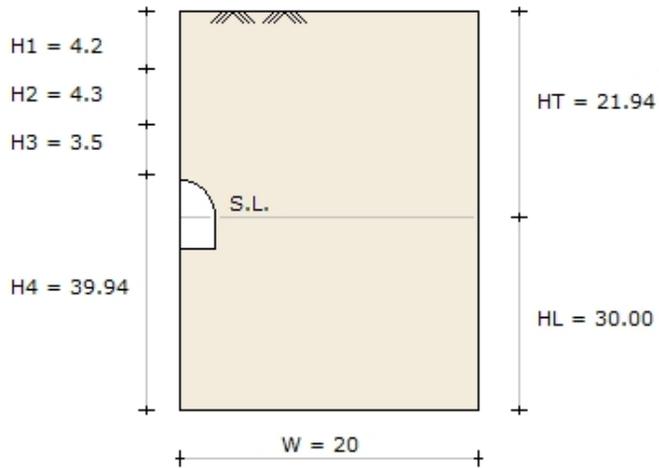


$$\begin{aligned}
 R_1 &= 5.24 \text{ M} & A_1 &= 60^\circ \\
 R_2 &= 4.24 \text{ M} & A_2 &= 30^\circ \\
 R_3 &= 9.86 \text{ M} & A_3 &= 19.781^\circ \\
 R_4 &= 23.86 \text{ M}
 \end{aligned}$$

Number of Rock Bolts ( NUMRB)	=	11
Length of Rock Bolts ( LRB)	=	3.0 M
Spacing of Rock Bolts ( TSPACING)	=	1.2 M
Thickness of Shotcrete ( TS)	=	15 Cm
Thickness of Liner ( TL)	=	30 Cm
Reinforcing Bar Area ( ASI)	=	22 Cm <sup>2</sup>
Reinforcing Bar Area ( ASO)	=	22 Cm <sup>2</sup>

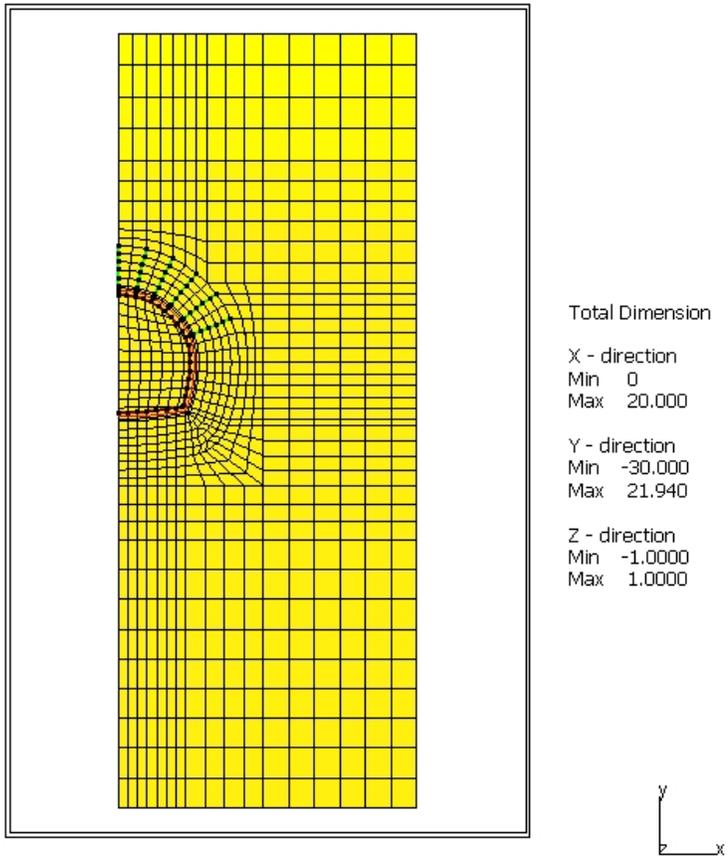
Figure 7.13 Tunnel dimensions used for example problem

MODEL=1 Single Tunnel (Half Section)



DELTA X = 2.0 DELTA Y = 2.0 NDYMAX = 40

Figure 7.14 Schematic tunnel section view for Model 1 example



NATM-2D MODEL 1 EXAMPLE PROBLEM

Figure 7.15 Generated finite element mesh for Model 1 example

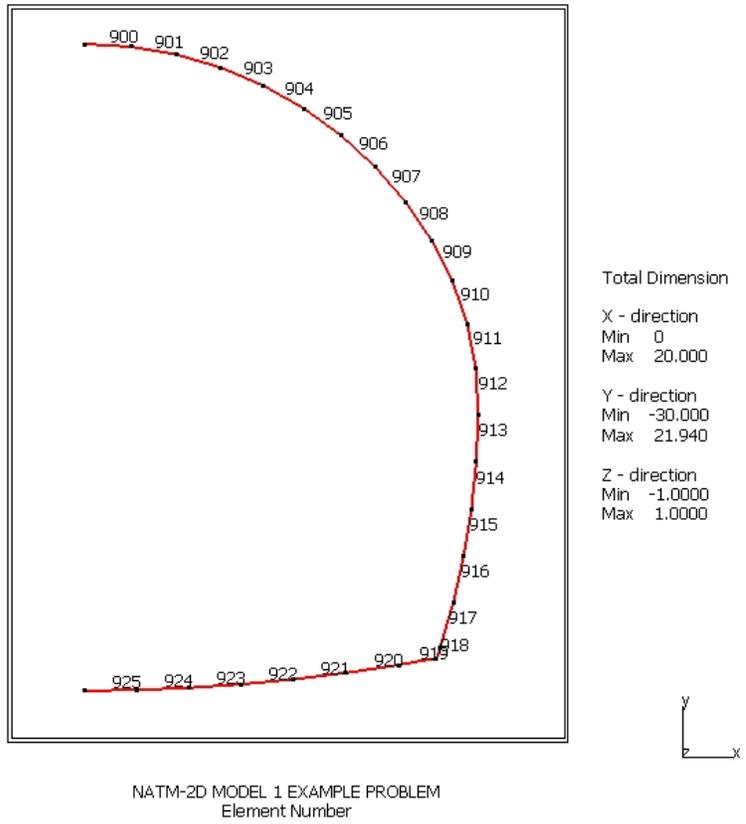
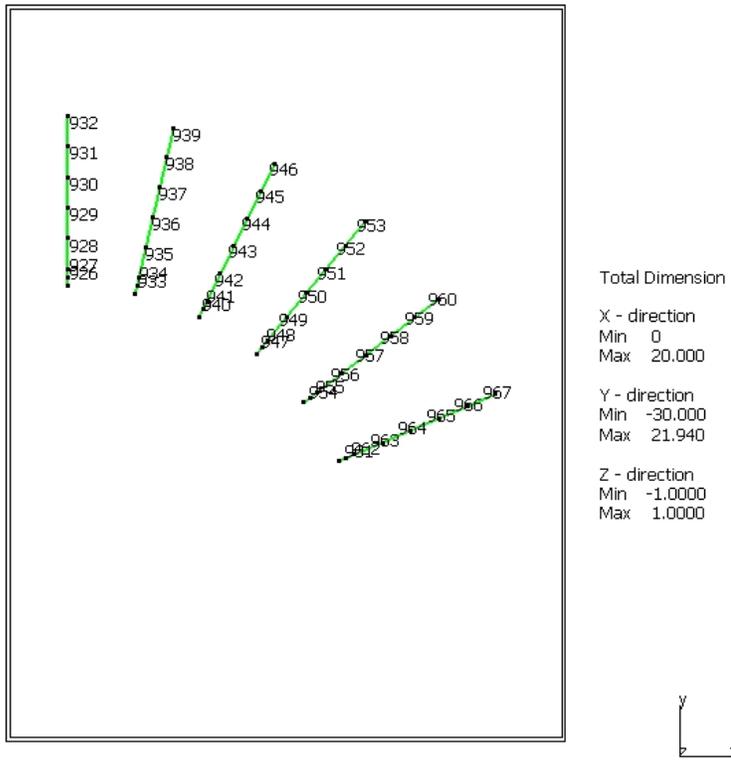


Figure 7.16 Generated beam element number for Model 1 example



NATM-2D MODEL 1 EXAMPLE PROBLEM  
Element Number

Figure 7.17 Generated truss element number for Model 1 example

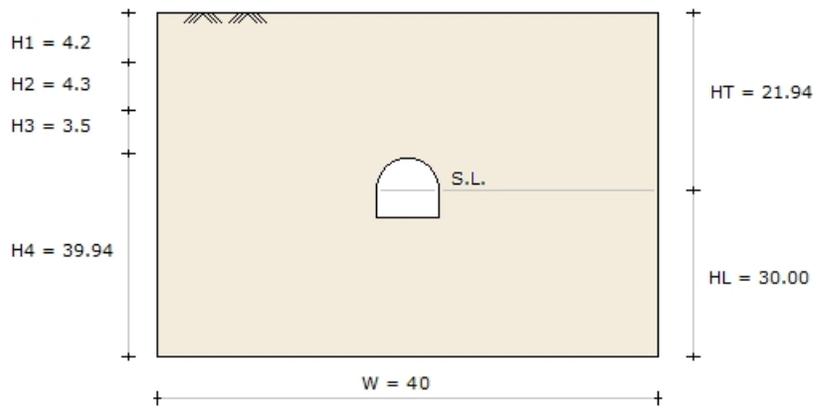
**Table 7.8** Listing of input file PD2-2.Dat

```

* CARD 1.1
* TITLE
  NATM-2D MODEL 2 EXAMPLE PROBLEM
* CARD 1.2
* IUNIT
  2
* CARD 1.3
* MODEL  IGEN  IEXMESH      ILCOUP
  2      0      0          0
* CARD 2.1
* HT      HL      W      DELTAX  DELTAX  NDYMAX
  21.94  30.    40.    2.0     2.0     40
* CARD 3.1
* NLAYER
  4
* CARD 3.2
* LAYERNO  H      IDH
  1         4.2   0
  2         4.3   0
  3         3.5   0
  4        39.94  0
* CARD 4.1
* R1      A1      R2      A2  R3      A3      R4      GR      GA
  5.24   60.    4.24   30.  9.86   19.781  23.86  1.0   0.5
* CARD 4.2
* INVSHOT  TS
  0         0.3
* CARD 4.3
* NUMRB   LRB      LSPACING  TSPACING  NSRB
  11      3.0     0.8       1.2       2
* CARD 5.1
* LDTYPE  DGW      GAMAW
  0       2.0     1.0
* END OF DATA

```

MODEL=2 Single Tunnel (Full Section)



DELTAX = 2.0 DELTAY = 2.0 NDYMAX = 40

Figure 7.18 Schematic tunnel section view for Model 2 example

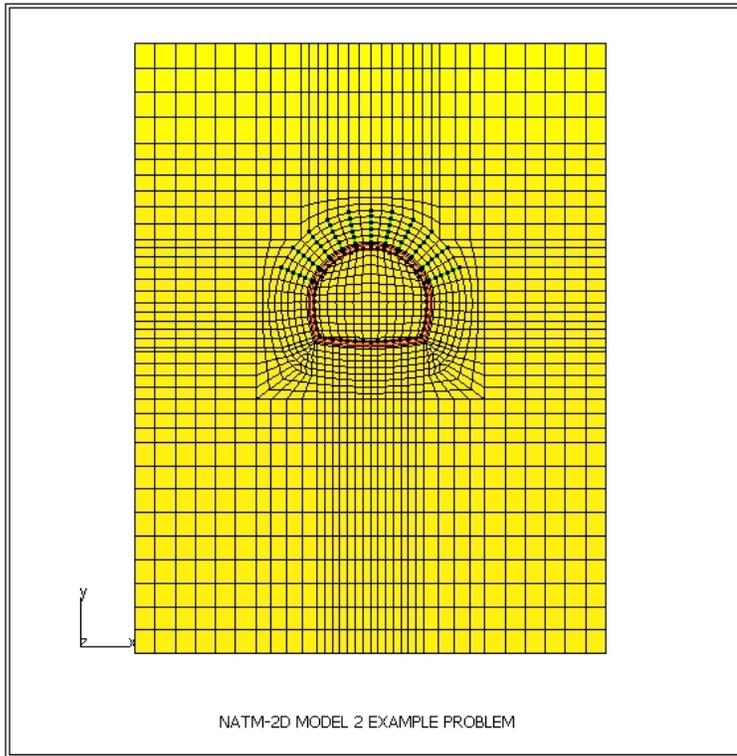


Figure 7.19 Generated finite element mesh for Model 2 example

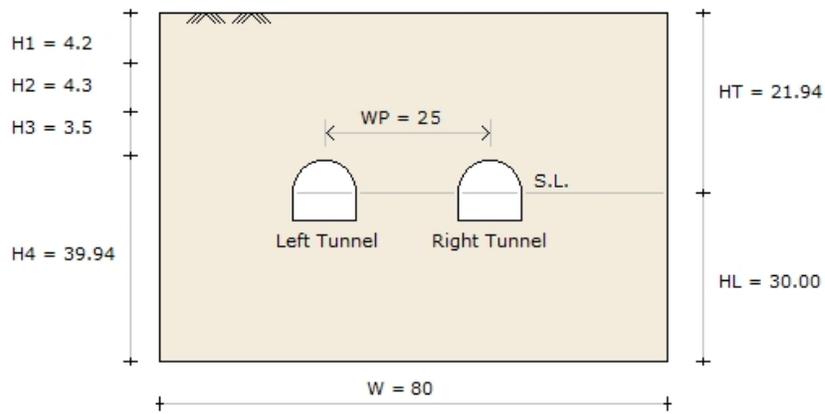
Table 7.9 Listing of input file PD2-3.Dat

```

* CARD 1.1
* TITLE
  NATM-2D MODEL 3 EXAMPLE PROBLEM
* CARD 1.2
* IUNIT
  2
* CARD 1.3
* MODEL  IGEN  IEXMESH  ILNCOUPL
  3      0      0        0
* CARD 2.1
* HT     HL     W      WP      DELTAX  DELTAY  NDYMAX
  21.94  30.   80.   25.   2.0     2.0     40
* CARD 3.1
* NLAYER
  4
* CARD 3.2
* LAYERNO  H      IDH
  1         4.2   0
  2         4.3   0
  3         3.5   0
  4        39.94  0
* CARD 4.1
* R1     A1     R2     A2     R3     A3     R4     GR     GA
  5.24   60.   4.24   30.   9.86   19.781  23.86  1.0   0.5
* CARD 4.2
* INVSHOT  TS
  0        0.3
* CARD 4.3
* NUMRB   LRB     LSPACING  TSPACING  NSRB
  11      3.0     0.8        1.2        2
* CARD 5.1
* LDTYPE  DGW     GAMAW
  0        2.0    1.0
* END OF DATA

```

MODEL=3 Two Tunnel (Symmetric Section)



DELTA X = 2.0 DELTA Y = 2.0 NDYMAX = 40

Figure 7.20 Schematic tunnel section view for Model 3 example

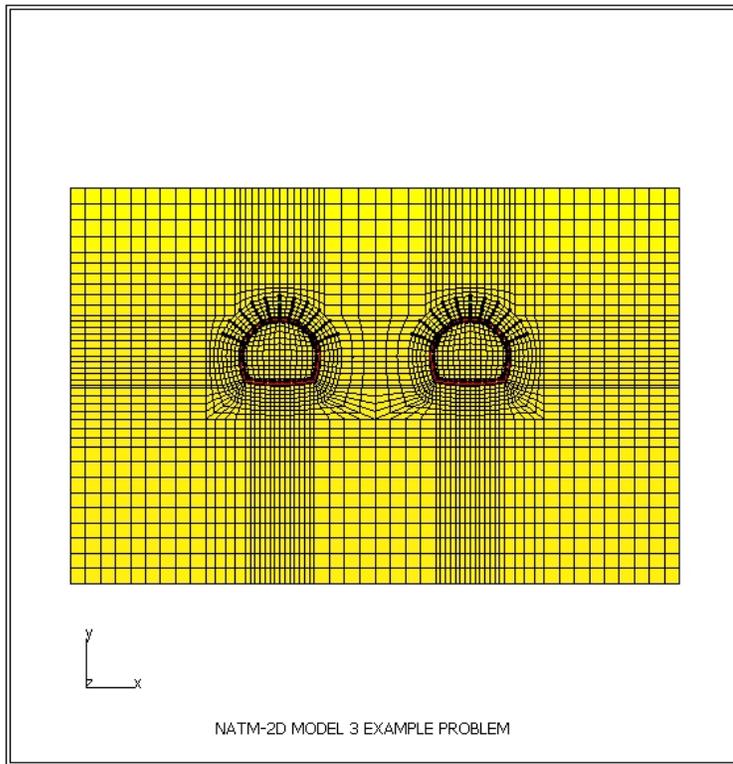


Figure 7.21 Generated finite element mesh for Model 3 example

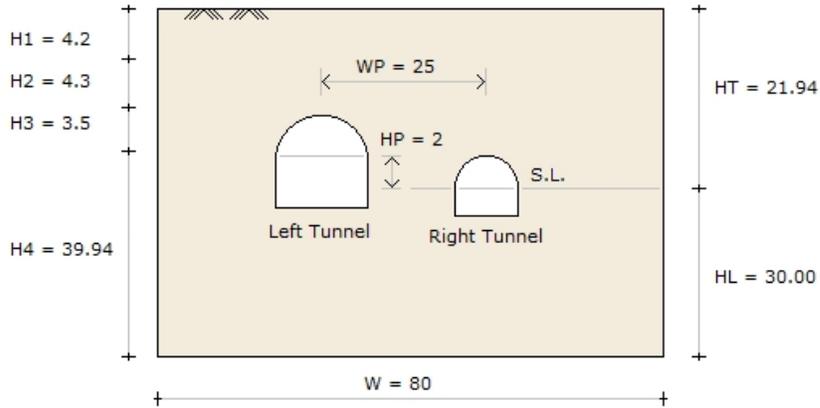
**Table 7.10** Listing of input file PD2-4.Dat

```

* CARD 1.1
* TITLE
  NATM-2D MODEL 4 EXAMPLE PROBLEM
* CARD 1.2
* IUNIT
  2
* CARD 1.3
* MODEL  IGEN  IEXMESH  ILNCOUPL
  4      0      0      0
* CARD 2.1
* HT      HL      W      WP      HP      DELTAX  DELTAY  NDYMAX
  21.94  30.    80.    25.    2.0    2.0     2.0     40
* CARD 3.1
* NLayer
  4
* CARD 3.2
* LAYERNO  H      IDH
  1         4.2   0
  2         4.3   0
  3         3.5   0
  4        39.94  0
* RIGHT TUNNEL
* CARD 4.1
* R1      A1      R2      A2  R3      A3      R4      GR      GA
  5.24   60.    4.24  30.  9.86  19.781  23.86  1.0   0.5
* CARD 4.2
* INVSHOT  TS
  0        0.3
* CARD 4.3
* NUMRB   LRB      LSPACING  TSPACING  NSRB
  11      3.0     0.8       1.2       2
* LEFT TUNNEL
* CARD 4.1
* R1      A1      R2      A2  R3      A3      R4      GR      GA
  7.24   60.    6.24  30. 11.86  21.781  25.86  1.0   0.5
* CARD 4.2
* INVSHOT  TS
  0        0.35
* CARD 4.3
* NUMRB   LRB      LSPACING  TSPACING  NSRB
  15      3.0     0.8       1.2       2
* CARD 5.1
* LDTYPE  DGW     GAMAW
  0        2.0    1.0
* END OF DATA

```

MODEL=4 Two Tunnel (Unsymmetric Section)



DELTA X = 2.0    DELTA Y = 2.0  
 NDYMAX = 40

Right Tunnel    Tunnel dimensions are shown in Figure 7.16

Left Tunnel     $R_1 = 7.24 \text{ M}$      $A_1 = 60^\circ$   
                   $R_2 = 6.24 \text{ M}$      $A_2 = 30^\circ$   
                   $R_3 = 11.86 \text{ M}$      $A_3 = 21.781^\circ$   
                   $R_4 = 25.86 \text{ M}$

Number of Rock Bolts ( NUMRB)    = 15  
 Length of Rock Bolts ( LRB)        = 3.0 M  
 Spacing of Rock Bolts ( TSPACING) = 1.2 M  
 Thickness of Shotcrete ( TS)        = 35 Cm

Figure 7.22    Schematic tunnel section view for Model 4 example

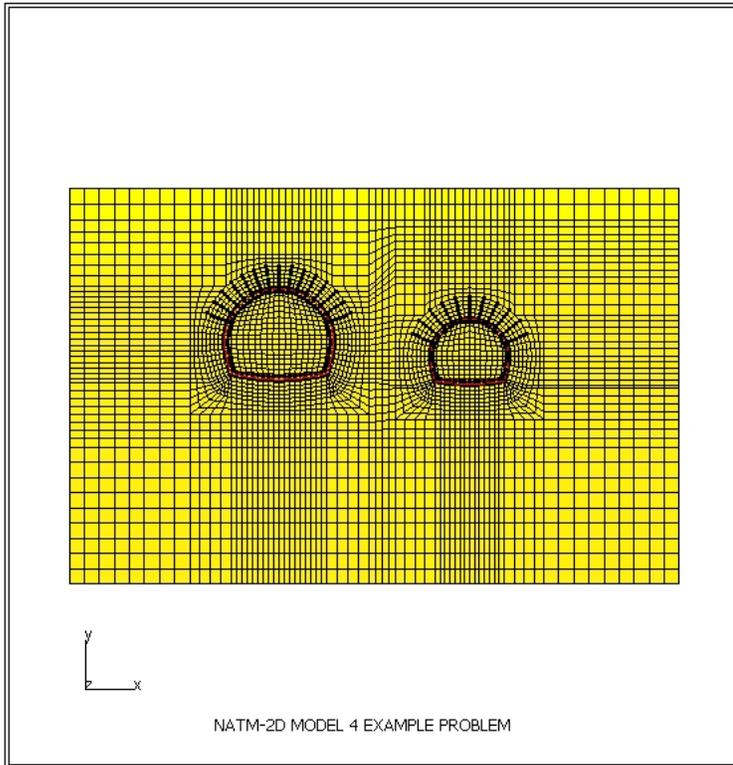


Figure 7.23 Generated finite element mesh for Model 4 example

### 7.3 CIRCLE-2D

CIRCLE-2D is the special pre-processing program to generate automatically two-dimensional finite element meshes and boundary conditions for circular sections. CIRCLE-2D has three different models:

Model 1	Quarter	Section
Model 2	Half	Section
Model 3	Full	Section

CIRCLE-2D is described in Section 7.4 of User's Manual and can be selected in the following order:

[Run](#) → [Mesh Generator](#) → [PreSmap](#) → [Circle 2D](#)

When you finish the execution of CIRCLE-2D, select [PLOT-3D](#) to plot the generated finite element mesh.

Three example problems are presented here to show all three types of available models. Figure 7.24 shows schematic section views which are used for example problems.

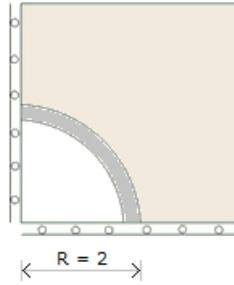
For each model, we will present:

- Listing of input file
- Graphical output of finite element mesh

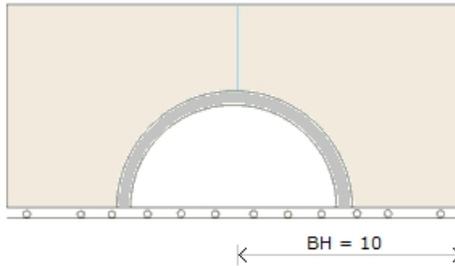
Model = 1  
(Quarter Section)

COREMAT1 = 1  
COREMAT2 = 2  
COREMAT3 = 3

JOINTMAT = 4  
NEARMAT = 5



Model = 2 (Half Section)



Model = 3 (Full Section)

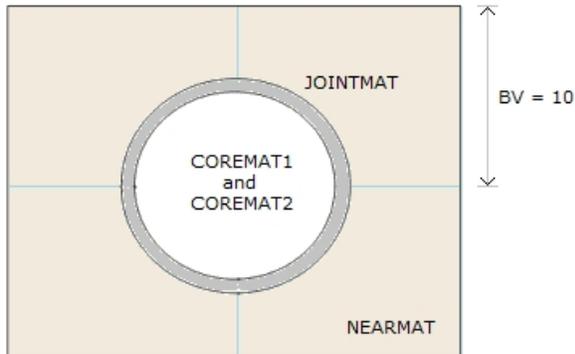


Figure 7.24 Schematic section views for CIRCLE-2D examples

Table 7.11 Listing of input file CIR1C\_Q.Dat (MODEL = 1)

```

* CARD 1.1
* TITLE
  MODEL 1 (COARSE, ALL QUAD)
* CARD 1.2
* MODEL      NSNEL      NSNODE
  1          1          1
* CARD 2.1
* R          FINEMESH  NEARMESH  NDIV      BH      BV
  2.0       0          0          5          10.0   10.0
* CARD 3.1
* COREMAT1  COREMAT2  COREMAT2J  JOINTMAT  NEARMAT
  1         2          3          4          5
* END OF DATA
    
```

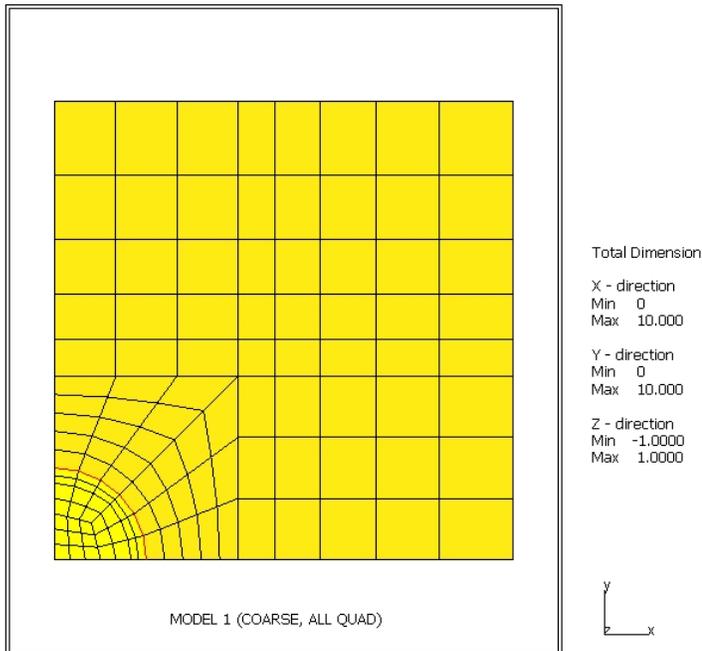


Figure 7.25 Generated finite element mesh for MODEL = 1

**Table 7.12** Listing of input file CIR2C\_Q.Dat (MODEL = 2)

```
* CARD 1.1
* TITLE
MODEL 2 (COARSE, ALL QUAD)
* CARD 1.2
* MODEL      NSNEL      NSNODE
2            1          1
* CARD 2.1
* R          FINEMESH  NEARMESH  NDIV      BH      BV
2.0         0          0          5         10.0   10.0
* CARD 3.1
* COREMAT1  COREMAT2  COREMAT2J  JOINTMAT  NEARMAT
1           2          3          4          5
* END OF DATA
```

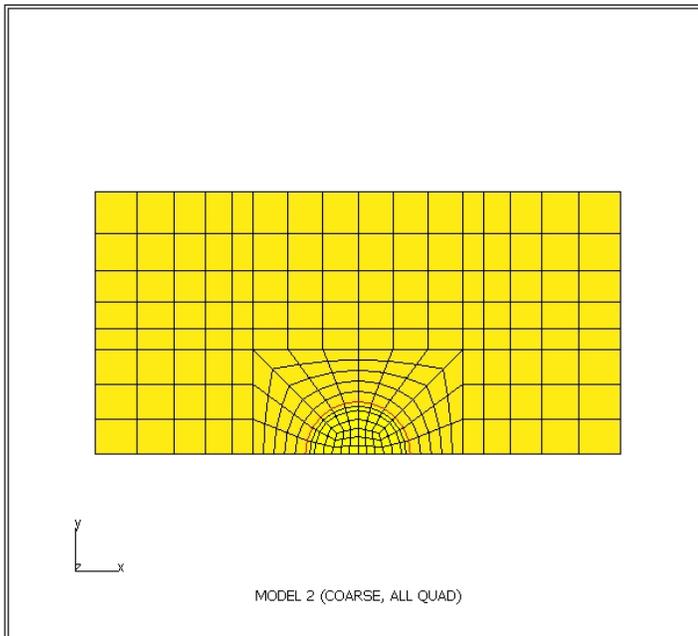


Figure 7.26 Generated finite element mesh for MODEL = 2

**Table 7.13** Listing of input file CIR3C\_Q.Dat (MODEL = 3)

```

* CARD 1.1
* TITLE
  MODEL 3 (COARSE, ALL QUAD)
* CARD 1.2
* MODEL      NSNEL      NSNODE
  3          1          1
* CARD 2.1
* R          FINEMESH  NEARMESH  NDIV      BH      BV
  2.0       0          0          5          10.0   10.0
* CARD 3.1
* COREMAT1  COREMAT2  COREMAT2J  JOINTMAT  NEARMAT
  1          2          3          4          5
* END OF DATA
    
```

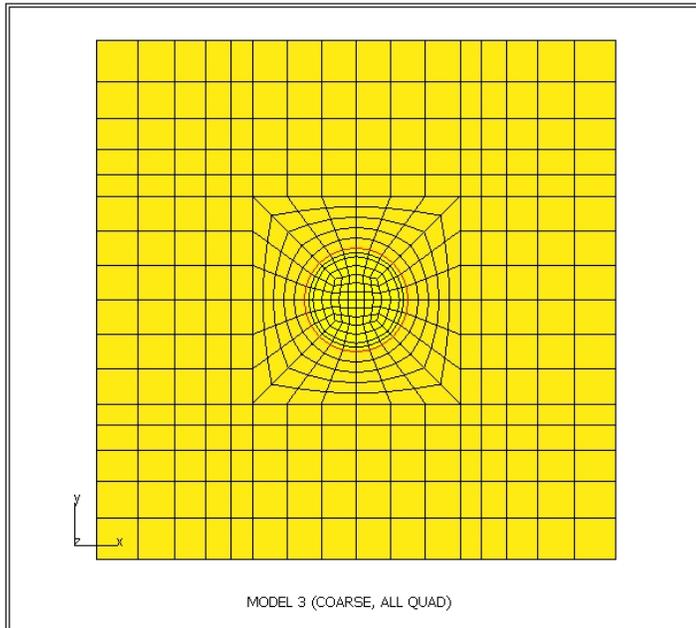


Figure 7.27 Generated finite element mesh for MODEL = 3



## **7.4 PRESMAP-3D**

PRESMAP-3D is the basic pre-processor which can be applied to model various types of 3 dimensional geometries. Input parameters of PRESMAP-3D have been described in detail in Section 7.5 of User's Manual.

PRESMAP-3D can be selected in the following order:

Run → Mesh Generator → PreSmap → Presmap 3D

When you finish the execution of PRESMAP-3D, select **PLOT-3D** to plot the generated mesh.

### **7.4.1 Example 1**

Figure 7.31 shows block nodes and block numbers for example 1. Detailed block information is listed in Table 7.14. There are 18 block nodes and 3 blocks. Both blocks 1 and 2 have 2 divisions in the x direction and only 1 division in y and z directions. Block 3 has 2 divisions in the z direction and only 1 division in x and y directions. To plot block diagram as shown in Figure 7.31, make the value of NBLOCK negative (example, NBLOCK=-3).

As boundary conditions, temperature is specified along the left surface of blocks 1 and 2 and external heat flow is specified along the right surface of block 3.

Graphical outputs are shown for:

- Node numbers in Figure 7.32
- Element numbers in Figure 7.33
- Boundary codes in Figure 7.34

**Table 7.14** Listing of input file GM3D.Rgn

```

* CARD 1.1
* TITLE
EXAMPLE 1
* CARD 1.2
* NBLOCK  NBNODE  NSNODE  NSNEL  CMFAC
3         18      1        1      1.0
* CARD 2.1
* NODE    X      Y      Z
1        0.0    4.0    5.0
2        3.0    4.0    5.0
3        4.0    4.0    5.0
4        0.0    0.0    5.0
5        3.0    0.0    5.0
6        4.0    0.0    5.0
*
7        0.0    4.0    2.0
8        3.0    4.0    2.0
9        4.0    4.0    2.0
10       0.0    0.0    2.0
11       3.0    0.0    2.0
12       4.0    0.0    2.0
*
13       0.0    4.0    0.0
14       3.0    4.0    0.0
15       4.0    4.0    0.0
16       0.0    0.0    0.0
17       3.0    0.0    0.0
18       4.0    0.0    0.0
*
-----
* CARD 3.1
BLOCK 1
* CARD 3.2
* ILAG
0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
2   1   4   5   8   7  10  11
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
0   0   0   0   0   0   0   0   0   0   0   0
* M21 M22 M23 M24 M25 M26 M27
* CARD 3.4.1
* NBOUND
2
* CARD 3.4.2
* IBTYPE  ID  IDF
1         0   0
4         1   0
    
```

## 7-60 PRESMAP-3D Example Problem

```
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IDH
   1      2    1    1    0
-----
* CARD 3.1
BLOCK 2
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
   8   7  10  11  14  13  16  17
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
   0   0   0   0   0   0   0   0   0   0   0   0
* M21 M22 M23 M24 M25 M26 M27
* CARD 3.4.1
* NBOUND
  2
* CARD 3.4.2
* IBTYPE  ID  IDF
   1      0   0
   4      1   1
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IDH
   2      2    1    1    0
-----
* CARD 3.1
BLOCK 3
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
   3   2   5   6  15  14  17  18
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
   9   8  11  12   0   0   0   0   0   0   0   0
* M21 M22 M23 M24 M25 M26 M27
* CARD 3.4.1
* NBOUND
  2
* CARD 3.4.2
* IBTYPE  ID  IDF
   1      0   0
   5      0   2
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IDH
   3      1    1    2    0
* End of Data
```

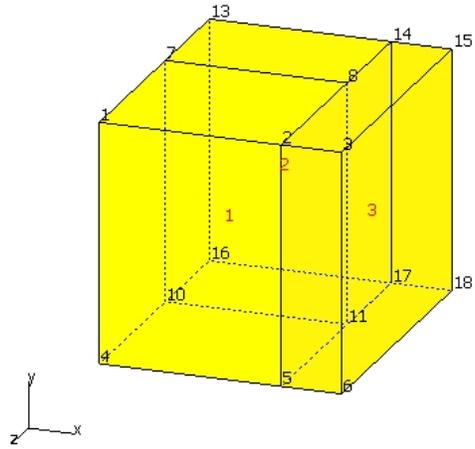


Figure 7.31 Block diagram for example 1

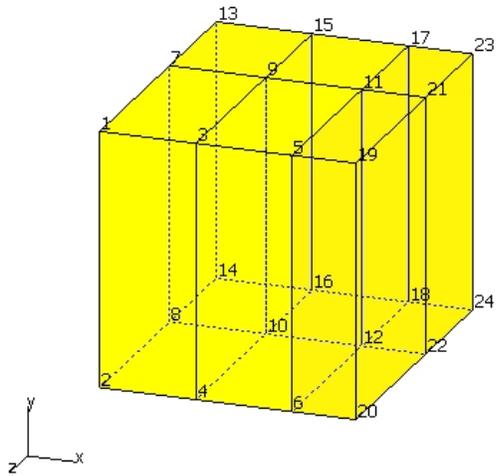


Figure 7.32 Generated node numbers for example 1

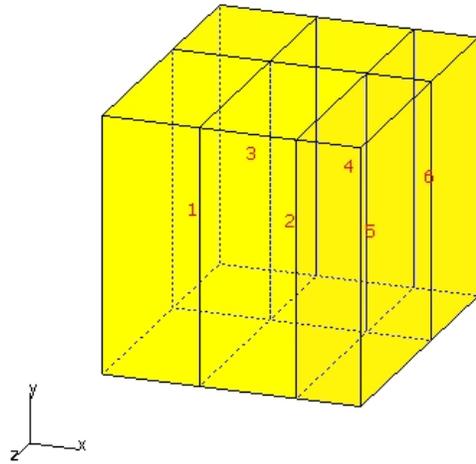


Figure 7.33 Generated element numbers for example 1

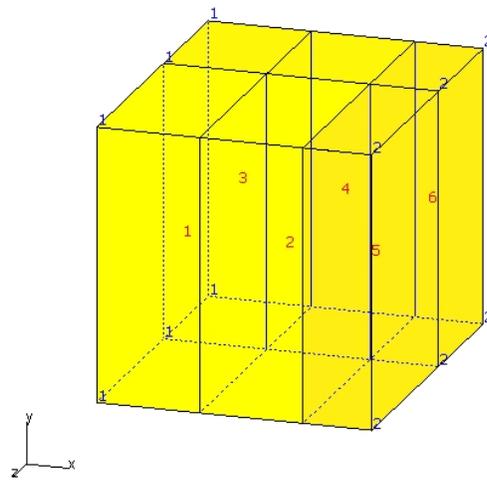


Figure 7.34 Generated function time history number (IDF)



## 7.5 CROSS-3D

CROSS-3D is the special pre-processing program developed to generate automatically three-dimensional finite element meshes and boundary conditions for crossing tunnels. There are 3 models available for CROSS-3D. Model 1 represents identical size tunnels crossing at right angle at the same level. Model 2 represents large and small tunnels crossing at right angle at the same level. And Model 3 represents lower and upper tunnels crossing at right angle with some clearance. Input parameters of each model have been described in detail in Section 7.6 of User's Manual.

CROSS-3D can be selected in the following order:

Run → Mesh Generator → PreSmap → Cross 3D

When you finish the execution of CROSS-3D, select **PLOT-3D** to plot the generated mesh.

It should be noted that once you finished running CROSS-3D, you will obtain an intermediate file with file extension **.Tmp** in working directory . This intermediate file contains useful block information which is essentially the input data to the program PRESMAP-3D.

### 7.5.1 Model 1

Figure 7.35 shows the schematic view of identical two crossing tunnels for Model 1 example problem. Dimensions defining tunnel location are listed in Figure 7.36. Table 7.15 shows the listing of input file **CROSS-M1.Dat**.

The output file, **CROSS-M1.Tmp** in Table 7.16, from CROSS-3D contains block information for the program PRESMAP-3D. Block diagram is shown in Figures 7.37.

Generated finite element mesh is shown in Figure 7.38. Figure 7.39 shows finite element meshes around tunnel core sections.

**Table 7.15** Listing of input file CROSS-M1.Dat

```

*
* CARD 1.1
* TITLE
  Identical two crossing tunnels (MODELNO = 1)
* CARD 1.2
* MODELNO  IH  NSNODE  NSNEL  CMFAC
      1      0      1      1      1.0
* CARD 2.1.1
* XL      YB      YT      ZL      t
  100.    50.    100.  100.  3.0
* CARD 2.1.2
* IPART  NDR  NTBND  NTOPN
      0      2      20      20
* CARD 2.1.3
* NTNODE
  9
* NODE  X      Y
      1  0.0    4.0
      2  2.8284  2.8284
      3  4.0    0.0
      4  4.0   -2.0
      5  0.0   -3.0
      6  1.53   3.7
      7  3.7    1.53
      8  4.0   -1.0
      9  2.0   -2.7
* CARD 3.1
* NBOUND
  2
* CARD 3.2
* IBTYPE ID  IDF
      1      0      0
      6      1      2
* END OF DATA

```

Table 7.16 Listing of output file CROSS-M1.Tmp

```

* CARD 1.1
* TITLE
  Identical two crossing tunnels (MODELNO = 1)
* CARD 1.2
* NBLOCK NBNODE NSNODE NSNEL          CMFAC
      25   150     1       1          .10000E+01
* CARD 2.1
* NODE   X-COORDINATE  Y-COORDINATE  Z-COORDINATE
      1   .00000E+00   .10000E+03   .10000E+03
      2   .00000E+00   .29125E+02   .10000E+03
      3   .00000E+00   .70000E+01   .10000E+03
      4   .00000E+00   .40000E+01   .10000E+03
      5   .00000E+00   .00000E+00   .10000E+03
      6   .00000E+00  -.30000E+01   .10000E+03
      7   .00000E+00  -.60000E+01   .10000E+03
      8   .00000E+00  -.18938E+02   .10000E+03
      9   .00000E+00  -.50000E+02   .10000E+03
     10   .26775E+01   .64750E+01   .10000E+03
     11   .15300E+01   .37000E+01   .10000E+03

-

    139   .40000E+01  -.50000E+01   .26688E+02
    140   .40000E+01  -.50000E+02   .26688E+02
    141   .70000E+01   .00000E+00   .29125E+02
    142   .70000E+01  -.20000E+01   .29125E+02
    143   .70000E+01  -.50000E+01   .29125E+02
    144   .70000E+01  -.50000E+02   .29125E+02
    145   .10000E+03   .10000E+03   .27459E+02
    146   .10000E+03   .49497E+01   .27459E+02
    147   .10000E+03   .00000E+00   .29125E+02
    148   .10000E+03  -.20000E+01   .29125E+02
    149   .10000E+03  -.50000E+01   .29125E+02
    150   .10000E+03  -.50000E+02   .29125E+02
=====
* CARD 3.1
  BLOCK  1
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
   12  4  5  14  58  50  51  60
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
   136 129 130 137  11  0  0  13  57  0  0  59

```

```

* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE  ID  IDF
  1    0    0
  2    0    0
  4    0    0
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IH
  1    4    4    5    0
* =====
* CARD 3.1
BLOCK  2
* CARD 3.2
* ILAG
  0
* CARD 3.3
*  I1  I2  I3  I4  I5  I6  I7  I8
  25   3   4  12  68  49  50  58
*  M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  135 128 129 136  10   0  11   0  56   0  57   0
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE  ID  IDF
  1    0    0
  2    0    0
  4    0    0
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IH
  2    4    2    5    0
-
* =====
* CARD 3.1
BLOCK           24
* CARD 3.2
* ILAG
  0
* CARD 3.3
*  I1  I2  I3  I4  I5  I6  I7  I8
  43  29  30  44 123  72  73 124
*  M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  148 142 143 149  36   0  37   0  81   0  82   0

```

## 7-68 CROSS-3D Example Problem

---

```
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE  ID  IDF
   1    0    0
   2    0    0
   5    0    0
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IH
   10    5    2    5    0
* =====
* CARD 3.1
  BLOCK                25
* CARD 3.2
* ILAG
  0
* CARD 3.3
*  I1  I2  I3  I4  I5  I6  I7  I8
   44  30  32  46  124  73  75  126
*  M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
   149 143 144 150  37  31  38  45  82  74  83  125
* CARD 3.4.1
* NBOUND
  4
* CARD 3.4.2
* IBTYPE  ID  IDF
   1    0    0
   2    0    0
   5    0    0
   7    0    0
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IH
   10    5    5    5    0
* =====
```

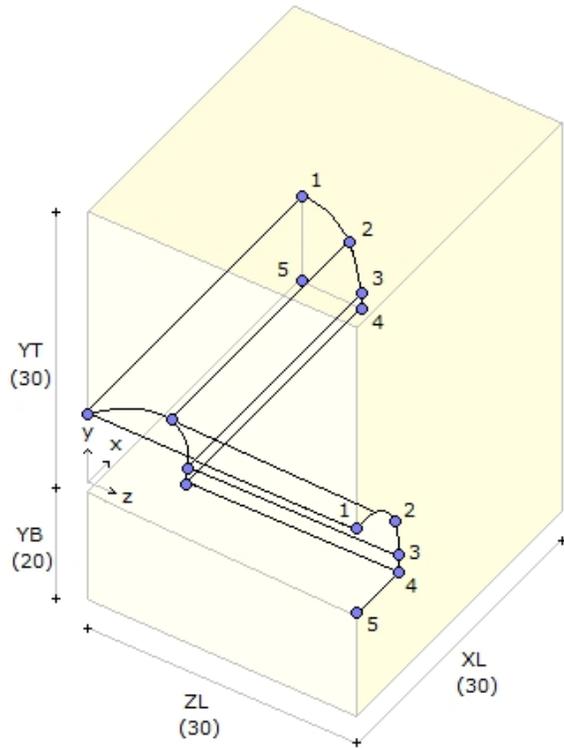


Figure 7.35 Schematic view of crossing tunnels for Model 1

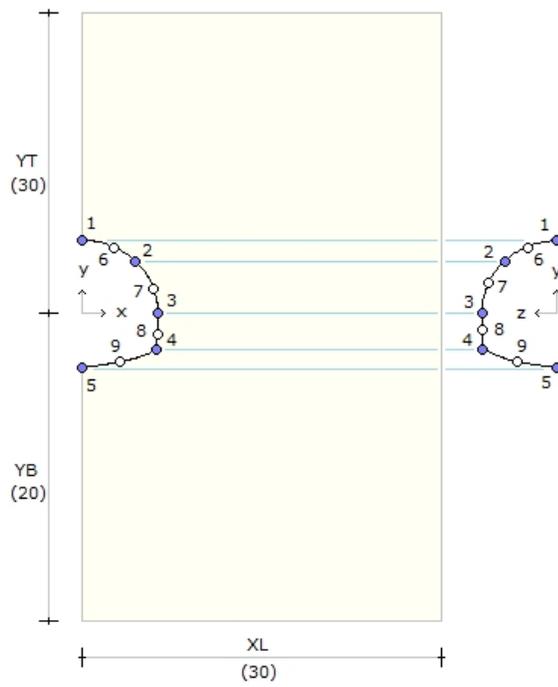


Figure 7.36 Tunnel shapes for Model 1

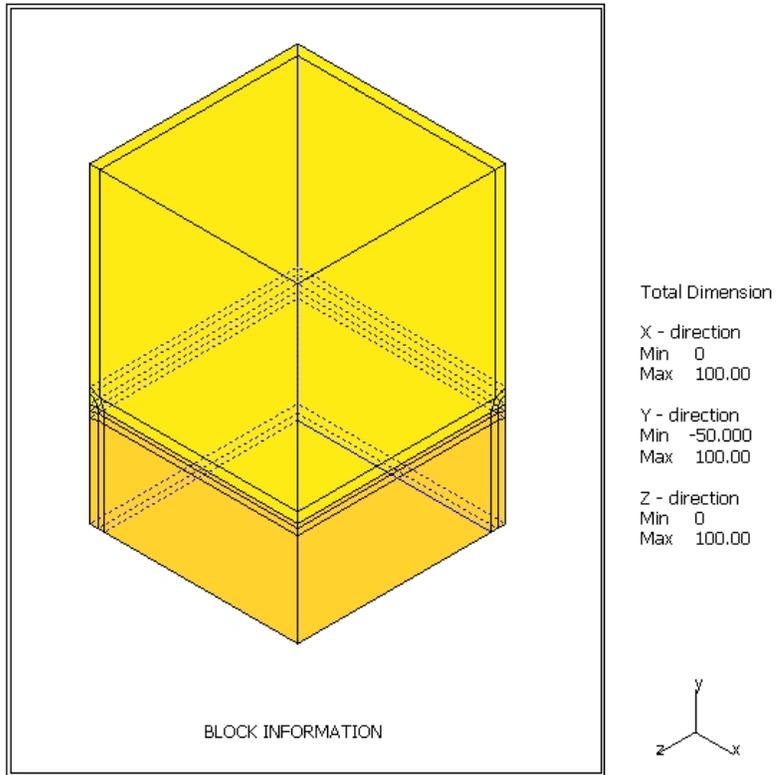


Figure 7.37 Block diagram for Model 1

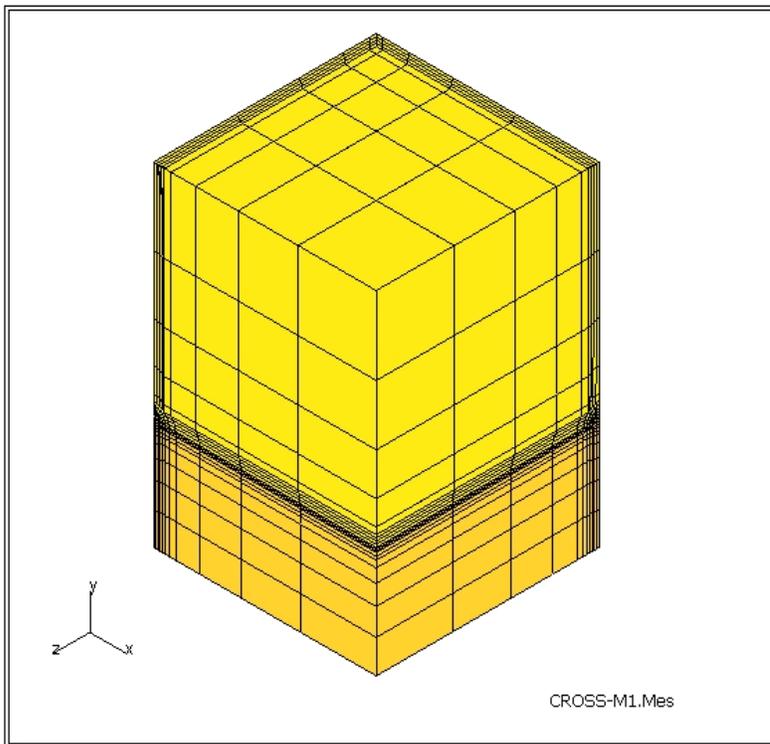


Figure 7.38 Generated finite element mesh for Model 1

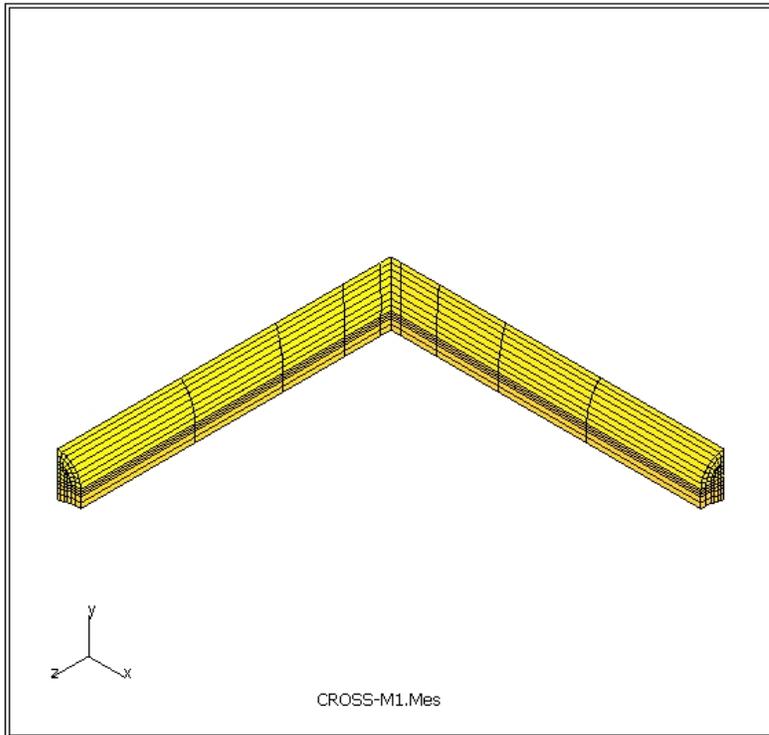


Figure 7.39 Generated mesh around tunnel core sections for Model 1

## 7.5.2 Model 2

Figure 7.40 shows the schematic view of large and small crossing tunnels for Model 2 example problem. Dimensions defining tunnel location are listed in Figure 7.41. Table 7.17 shows the listing of input file **CROSS-M2.Dat**.

The output file, **CROSS-M2.Tmp** in Table 7.18, from CROSS-3D contains block information for the program PRESMAP-3D. Block diagram is shown in Figures 7.42.

Generated finite element mesh is shown in Figure 7.43. Figure 7.44 shows the finite element meshes around tunnel core sections.

**Table 7.17** Listing of input file CROSS-M2.Dat

```
* CARD 1.1
* TITLE
Large and small crossing tunnels (MODELNO = 2)
* CARD 1.2
* MODELNO  IH  NSNODE  NSNEL  CMFAC
      2      0      1      1      1.0
* CARD 2.2.1
* XL      YB      YT      ZL      t1      ts
      30.     20.     30.     30.     3.0     3.0
* CARD 2.2.2
* IPART  NDR  NTBND  NTOPNL  NTOPNS
      0      2      20      20      14
* CARD 2.2.3
* NTLNODE
      9
* NODE  X      Y
      1  0.0     9.0
      2  4.3     7.0
      3  6.6     4.0
      4  7.2     2.0
      5  7.3     0.0
      6  7.3    -2.0
      7  0.0    -3.0
      8  2.3     8.3
      9  5.7     5.5
```

```

* CARD 2.3.3
* NTSNODE
8
* NODE Z Y
1 0.0 4.0
2 3.5 2.0
3 4.0 0.0
4 4.0 -2.0
5 0.0 -2.0
6 2.6 3.0
7 3.9 1.0
8 4.0 -1.0
* CARD 3.1
* NBOUND
2
* CARD 3.2
* IBTYPE ID IDF
1 0 0
6 1 2
* END OF DATA

```

**Table 7.18** Listing of output file CROSS-M2.Tmp

```

* CARD 1.1
* TITLE
Large and small crossing tunnels (MODELNO = 2)
* CARD 1.2
* NBLOCK NBNODE NSNODE NSNEL CMFAC
34 201 1 1 .10000E+01
* CARD 2.1
* NODE X-COORDINATE Y-COORDINATE Z-COORDINATE
1 .00000E+00 .30000E+02 .30000E+02
2 .49793E+01 .30000E+02 .30000E+02
3 .81520E+01 .30000E+02 .30000E+02
4 .30000E+02 .30000E+02 .30000E+02
5 .00000E+00 .12000E+02 .30000E+02
6 .49793E+01 .99021E+01 .30000E+02
7 .81520E+01 .70000E+01 .30000E+02
8 .30000E+02 .70000E+01 .30000E+02
9 .00000E+00 .90000E+01 .30000E+02
10 .43000E+01 .70000E+01 .30000E+02
11 .66000E+01 .40000E+01 .30000E+02
-
193 .10300E+02 -.12500E+02 .70000E+01
194 .30000E+02 -.12500E+02 .70000E+01

```

**7-76** CROSS-3D Example Problem

```

195   .30000E+02   -.12500E+02   .40000E+01
196   .72500E+01   .10000E+01   .39000E+01
197   .73000E+01   -.10000E+01   .40000E+01
198   .00000E+00   .00000E+00   .00000E+00
199   .00000E+00   .00000E+00   .00000E+00
200   .10212E+02   .17500E+01   .68250E+01
201   .10300E+02   -.10000E+01   .70000E+01

```

\* =====

```

* CARD 3.1
  BLOCK 1
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  10  9  12  11  41  40  42  43
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  190 166 167 177 112  0  0  113 124  0  0  125
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE ID  IDF
  1  0  0
  2  0  0
  4  0  0
* CARD 3.5
* MATNO NDX  NDY  NDZ  IH
  1  4  3  6  0

```

\* =====

```

* CARD 3.1
  BLOCK 2
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  11  12  13  14  43  42  22  23
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  177 167 168 178  0  0  0  114  0  159  0  147
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE ID  IDF
  1  0  0
-

```

```

* =====
* CARD 3.1
  BLOCK           33
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  51  50  54  55  63  62  66  67
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  144 185 186 145  91  0  92  0 156  0 157  0
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE  ID  IDF
  1  0  0
  2  0  0
  5  0  0
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IH
  10  6  2  6  0
* =====
* CARD 3.1
  BLOCK           34
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  55  54  58  59  67  66  72  73
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  145 186 187 146  92  95  97  96 157 193 158 194
* CARD 3.4.1
* NBOUND
  4
* CARD 3.4.2
* IBTYPE  ID  IDF
  1  0  0
  2  0  0
  5  0  0
  7  0  0
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IH
  10  6  5  6  0
* =====

```

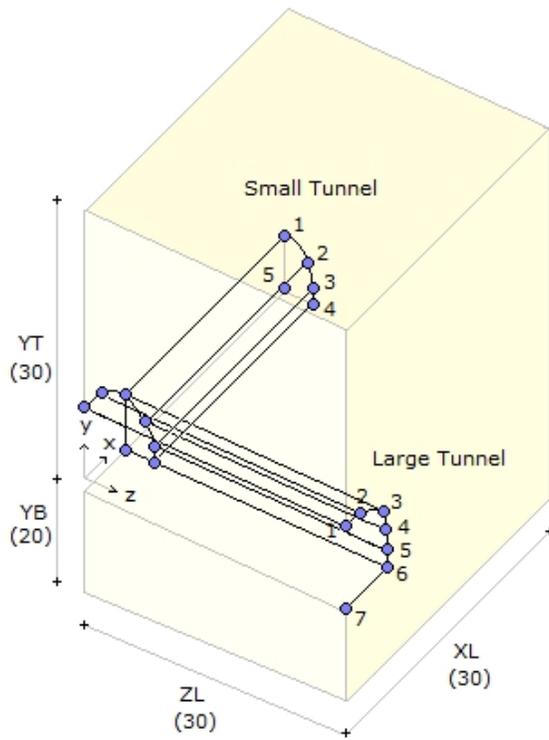


Figure 7.40 Schematic view of crossing tunnels for Model 2

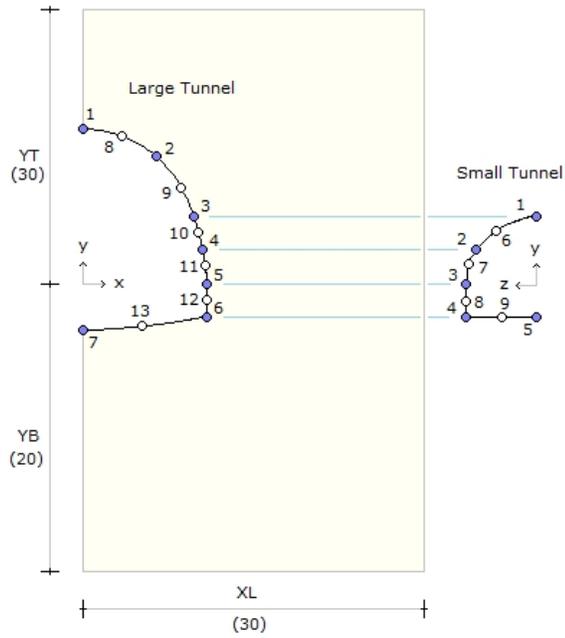


Figure 7.41 Tunnel shapes for Model 2

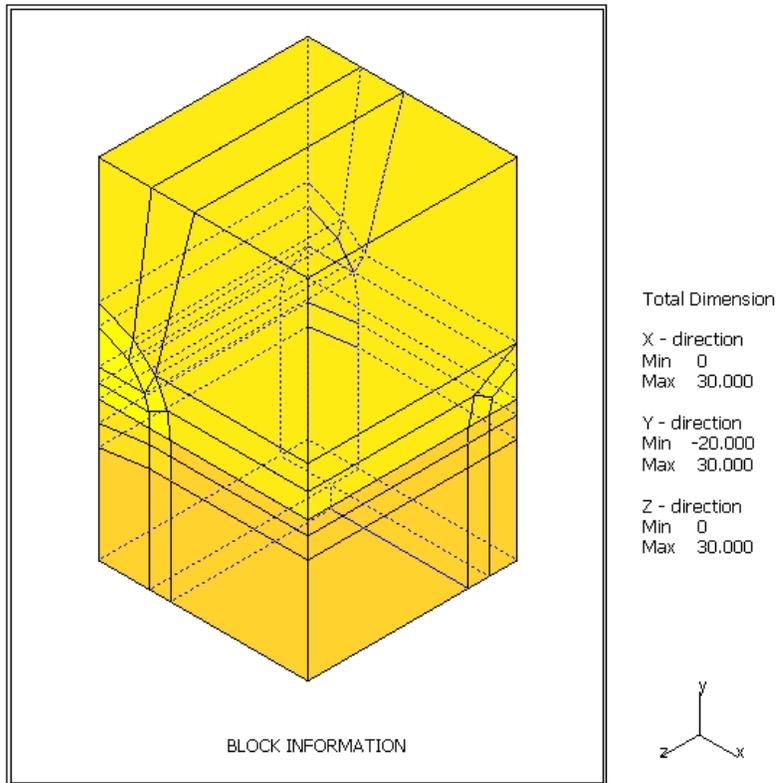


Figure 7.42 Block diagram for Model 2

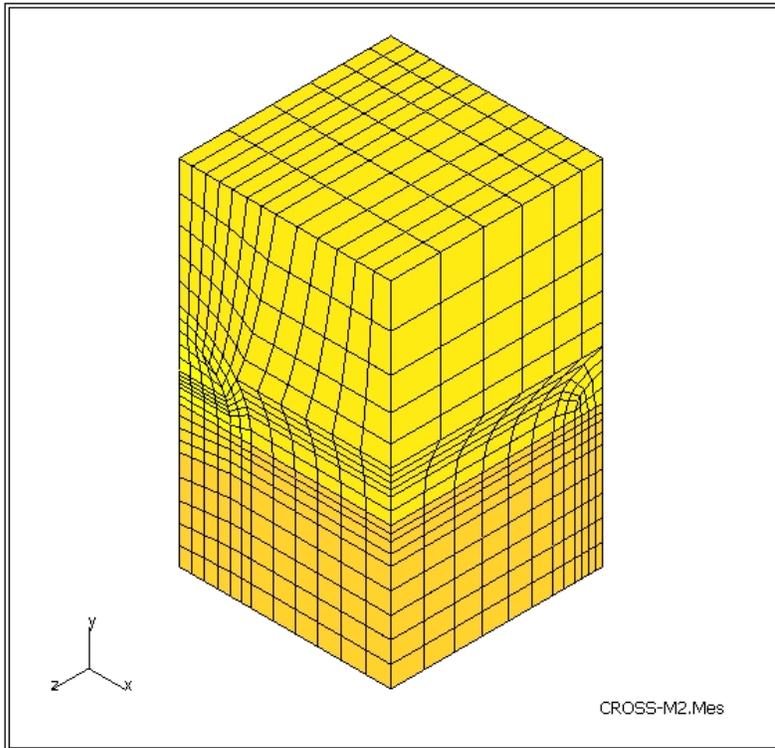


Figure 7.43 Generated finite element mesh for Model 2

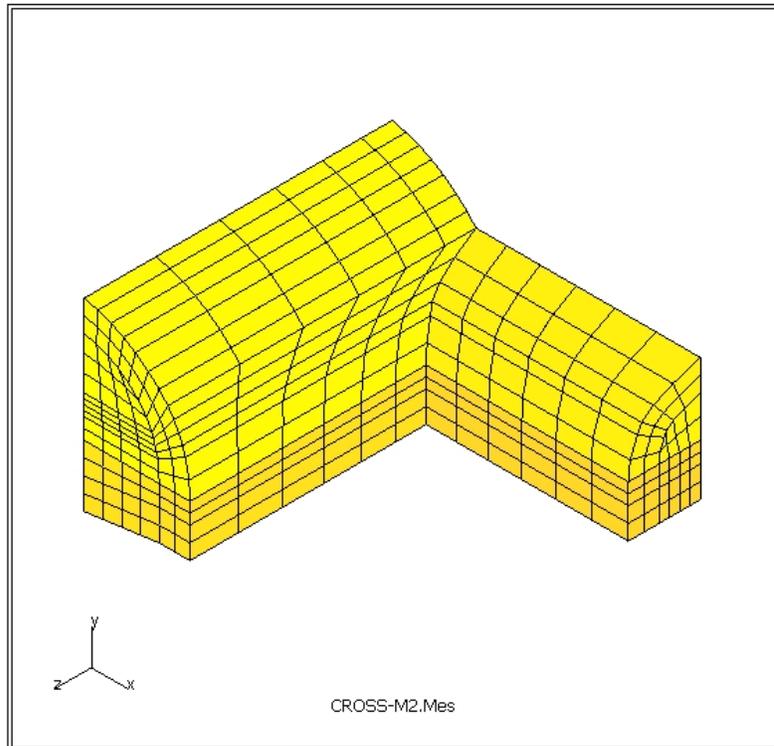


Figure 7.44 Generated mesh around tunnel core sections for Model 2

### 7.5.3 Model 3

Figure 7.45 shows the schematic view of crossing tunnels with clearance for Model 3 example problem. Dimensions defining tunnel location are listed in Figure 7.46. Table 7.19 shows the listing of input file **CROSS-M3.Dat**.

The output file, **CROSS-M3.Tmp** in Table 7.20, from CROSS-3D contains block information for the program PRESMAP-3D. Block diagram is shown in Figures 7.47.

Generated finite element mesh is shown in Figure 7.48. Figure 7.49 shows the finite element meshes around tunnel core sections.

**Table 7.19** Listing of input file **CROSS-M3.Dat**

```

* CARD 1.1
* TITLE
  Crossing tunnels with clearance (MODELNO = 3)
* CARD 1.2
* MODELNO  IH  NSNODE  NSNEL  CMFAC
   3         0      1      1      1.0
* CARD 2.3.1
* XL      YB      YC      YT      ZL      t1      tu
  30.     20.     16.     20.     30.     3.0     3.0
* CARD 2.3.2
* NDRL     NDRU     NTBND  NTOPNL  NTOPNS
   2       2       20     14     14
* CARD 2.3.3
* NTLNODE
  9
* NODE     X       Y
   1     0.0     4.0
   2     2.828   2.828
   3     4.0     0.0
   4     2.828  -2.828
   5     0.0    -4.0
   6     1.531   3.7
   7     3.7     1.531
   8     3.7    -1.531
   9     1.531  -3.7
* CARD 2.3.3
* NTUNODE
  9

```

```

* NODE   Z       Y
   1   0.0     19.
   2   2.12    18.12
   3   3.0     16.
   4   2.12    13.88
   5   0.0     13.
   6   1.148   18.77
   7   2.77    17.148
   8   2.77    14.852
   9   1.148   13.23
* CARD 3.1
* NBOUND
   6
* CARD 3.2
* IBTYPE ID   IDF
   1   0     0
   6   1     2
* END OF DATA

```

Table 7.20 Listing of output file CROSS-M3.Tmp

```

* CARD 1.1
* TITLE
  Crossing tunnels with clearance (MODELNO = 3)
* CARD 1.2
* NBLOCK  NBNODE  NSNODE   NSNEL       CMFAC
          44     226       1         1       .10000E+01
* CARD 2.1
* NODE    X-COORDINATE  Y-COORDINATE  Z-COORDINATE
   1      .30000E+02    .36000E+02    .00000E+00
   2      .30000E+02    .29313E+02    .00000E+00
   3      .30000E+02    .22000E+02    .00000E+00
   4      .30000E+02    .19000E+02    .00000E+00
   5      .30000E+02    .16000E+02    .00000E+00
   6      .30000E+02    .13000E+02    .00000E+00
   7      .30000E+02    .10000E+02    .00000E+00
   8      .30000E+02    .49490E+01    .00000E+00
   9      .30000E+02    .00000E+00    .00000E+00
  10      .30000E+02   -.49490E+01    .00000E+00
  11      .30000E+02   -.12459E+02    .00000E+00
  -
  218     .49490E+01   -.20000E+02    .14792E+02

```

```

223   .30000E+02   .49490E+01   .14792E+02
224   .30000E+02   .00000E+00   .14792E+02
225   .30000E+02  -.49490E+01   .14792E+02
226   .30000E+02  -.20000E+02   .14792E+02

```

\* =====

```

* CARD 3.1
  BLOCK 1
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  171 151 152 173 120 113 114 122
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  213 164 165 215 170  0  0 172 119  0  0 121
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE ID  IDF
  1  0  0
  2  0  0
  4  0  0
* CARD 3.5
* MATNO NDX  NDY  NDZ  IH
  1  3  3  6  0

```

\* =====

```

* CARD 3.1
  BLOCK 2
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  120 113 114 122 39 54 55 41
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  0  0  0  0 119  0  0 121 38  0  0 40
* CARD 3.4.1
* NBOUND
  3
* CARD 3.4.2
* IBTYPE ID  IDF
  1  0  0
  3  0  0
  4  0  0

```

-

```

* =====
* CARD 3.1
  BLOCK 43
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  205 187 189 207 77 131 133 79
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  225 217 218 226 196 188 197 206 143 132 144 78
* CARD 3.4.1
* NBOUND
  4
* CARD 3.4.2
* IBTYPE ID IDF
  1  0  0
  2  0  0
  5  0  0
  7  0  0
* CARD 3.5
* MATNO NDX NDY NDZ IH
  11  6  5  6  0
* =====
* CARD 3.1
  BLOCK 44
* CARD 3.2
* ILAG
  0
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  77 131 133 79 10 34 36 12
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  0  0  0  0 143 132 144 78 21 35 22 11
* CARD 3.4.1
* NBOUND
  4
* CARD 3.4.2
* IBTYPE ID IDF
  1  0  0
  3  0  0
  5  0  0
  7  0  0
* CARD 3.5
* MATNO NDX NDY NDZ IH
  11  6  5  3  0
* =====

```

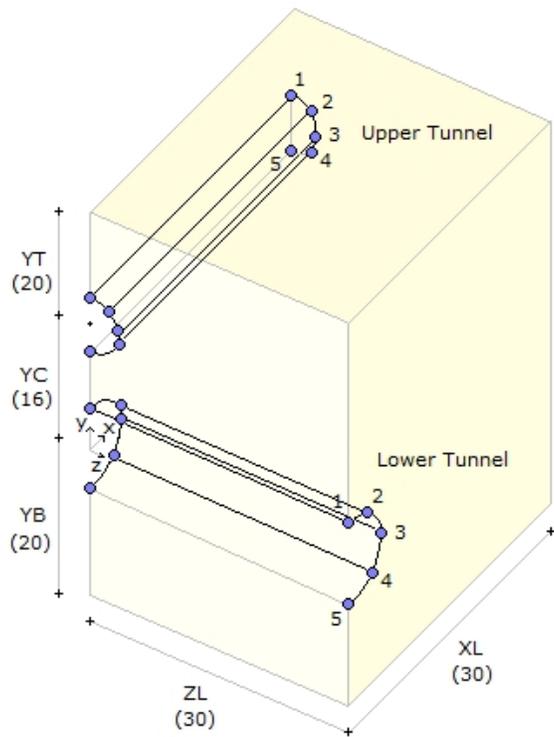


Figure 7.45 Schematic view of crossing tunnels for Model 3

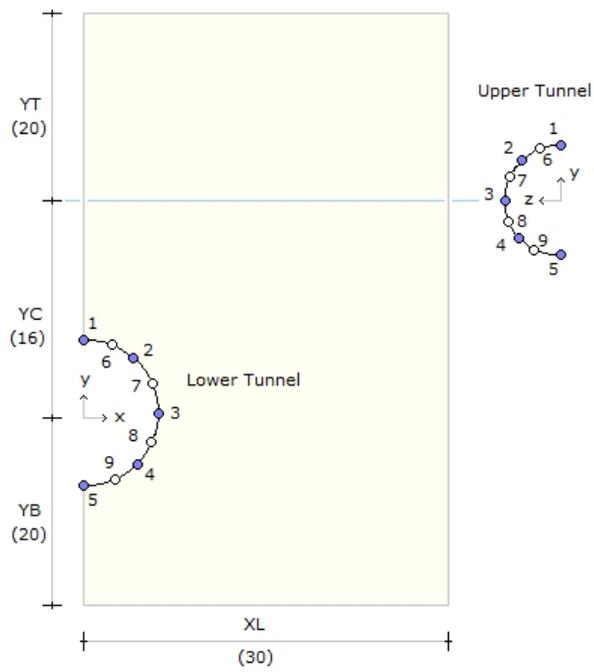


Figure 7.46 Tunnel shapes for Model 3

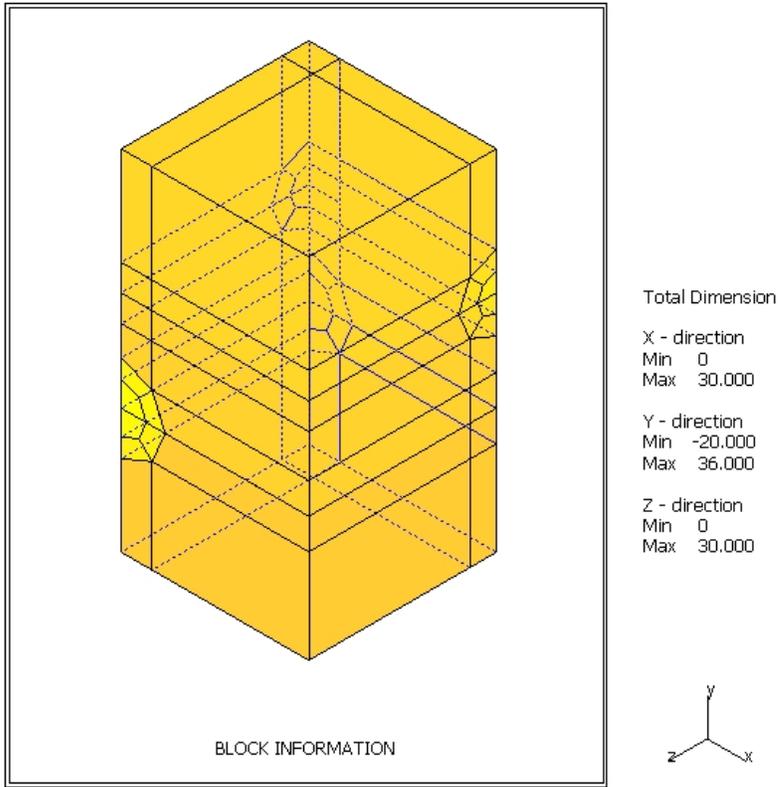


Figure 7.47 Block diagram for Model 3

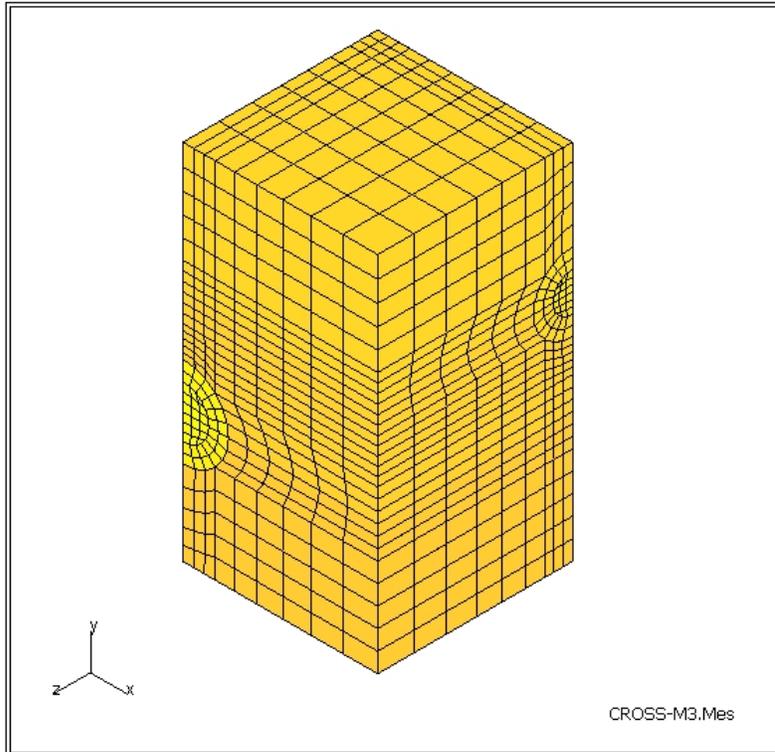


Figure 7.48 Generated finite element mesh for Model 3

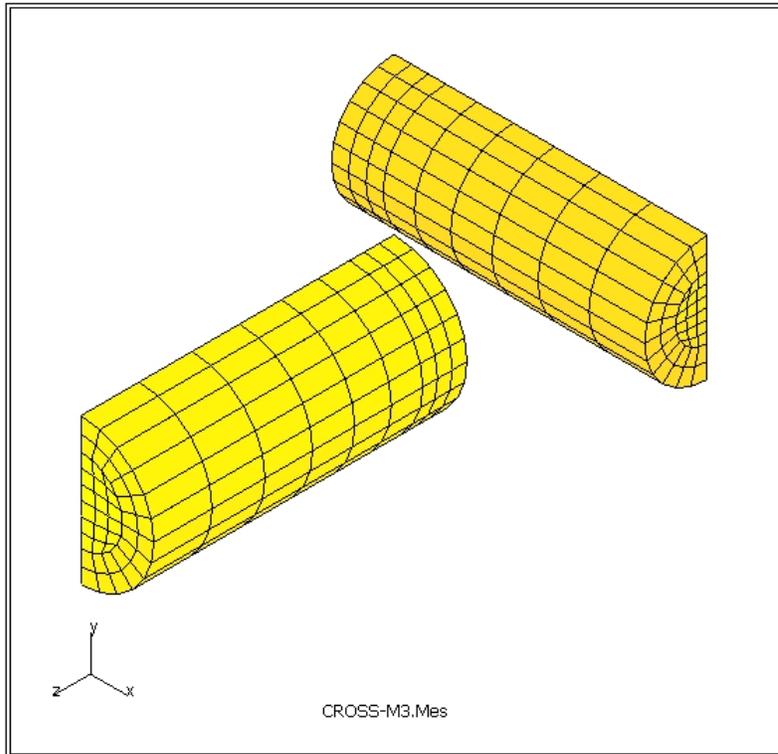


Figure 7.49 Generated mesh around tunnel core sections for Model 3

## 7.6 GEN-3D

GEN-3D is used to generate nodal coordinates, element indexes, boundary codes, external loads and transmitting boundaries in 3-dimensional coordinate system by extending typical 2-dimensional output from PRESMAP-2D, NATM-2D, CIRCLE-2D, or PRESMAP-GP. Input parameters of GEN-3D have been described in detail in Section 7.7 of User's Manual.

GEN-3D can be selected in the following order:

Run → Mesh Generator → PreSmap → Gen 3D

When you finish the execution of GEN-3D, select [PLOT-3D](#) to plot the generated mesh.

### 7.6.1 Example 1: 3-D Tunnel Mesh Generation

In Sections 7.1 and 8.1, a typical tunnel section having Core, Near-field, and Far-field regions has been constructed using PRESMAP-2D and ADDRGN-2D. Table 7.21 shows the listing of the file, [Ex1-2D.Mes](#), containing this typical 2D section. Graphical output for this typical 2D section is presented in Figure 7.50.

In this example, we want to extend this typical 2D section in XY coordinate into 5 sections in Z coordinate using GEN-3D as schematically illustrated in Figure 7.51. The input file, [Ex1.Dat](#) in Table 7.22, has been prepared according to Section 7.7 of User's Manual.

Generated 3-dimensional finite element mesh is shown in Figures 7.52. The output file from GEN-3D contains nodal coordinates, element indexes, and boundary codes which are compatible to format of SMAP-W3 Mesh File.

**Table 7.21 Listing of typical 2D section Ex1-2D.Mes for Example 1**

COMBINED REGION : Ex1-2D.Mes

NUMNP NCONT NBEAM NTROSS  
506 464 0 0

NODAL COORDINATES

NODE	ID	IDF	XC	YC	T	CF
1	0	0	.000000E+00	.474000E+01	.150000E+02	.000000E+00
2	0	0	.684000E+00	.469500E+01	.150000E+02	.000000E+00
3	0	0	.135600E+01	.456200E+01	.150000E+02	.000000E+00
4	0	0	.200500E+01	.434100E+01	.150000E+02	.000000E+00
5	0	0	.262000E+01	.403800E+01	.150000E+02	.000000E+00
6	0	0	.319000E+01	.366000E+01	.150000E+02	.000000E+00
7	0	0	.370500E+01	.320500E+01	.150000E+02	.000000E+00
8	0	0	.000000E+00	.395000E+01	.150000E+02	.000000E+00
9	0	0	.714000E+00	.384225E+01	.150000E+02	.000000E+00
10	0	0	.142200E+01	.369050E+01	.150000E+02	.000000E+00
11	0	0	.210460E+01	.349792E+01	.150000E+02	.000000E+00
-						
-						
494	0	0	.261500E+02	-.241500E+02	.150000E+02	.000000E+00
495	0	0	.320000E+02	-.241500E+02	.150000E+02	.000000E+00
496	0	0	.000000E+00	-.300000E+02	.150000E+02	.000000E+00
497	0	0	.233333E+01	-.300000E+02	.150000E+02	.000000E+00
498	0	0	.466667E+01	-.300000E+02	.150000E+02	.000000E+00
499	0	0	.700000E+01	-.300000E+02	.150000E+02	.000000E+00
500	0	0	.933333E+01	-.300000E+02	.150000E+02	.000000E+00
501	0	0	.116667E+02	-.300000E+02	.150000E+02	.000000E+00
502	0	0	.140000E+02	-.300000E+02	.150000E+02	.000000E+00
503	0	0	.171500E+02	-.300000E+02	.150000E+02	.000000E+00
504	0	0	.212000E+02	-.300000E+02	.150000E+02	.000000E+00
505	0	0	.261500E+02	-.300000E+02	.150000E+02	.000000E+00
506	0	0	.320000E+02	-.300000E+02	.150000E+02	.000000E+00

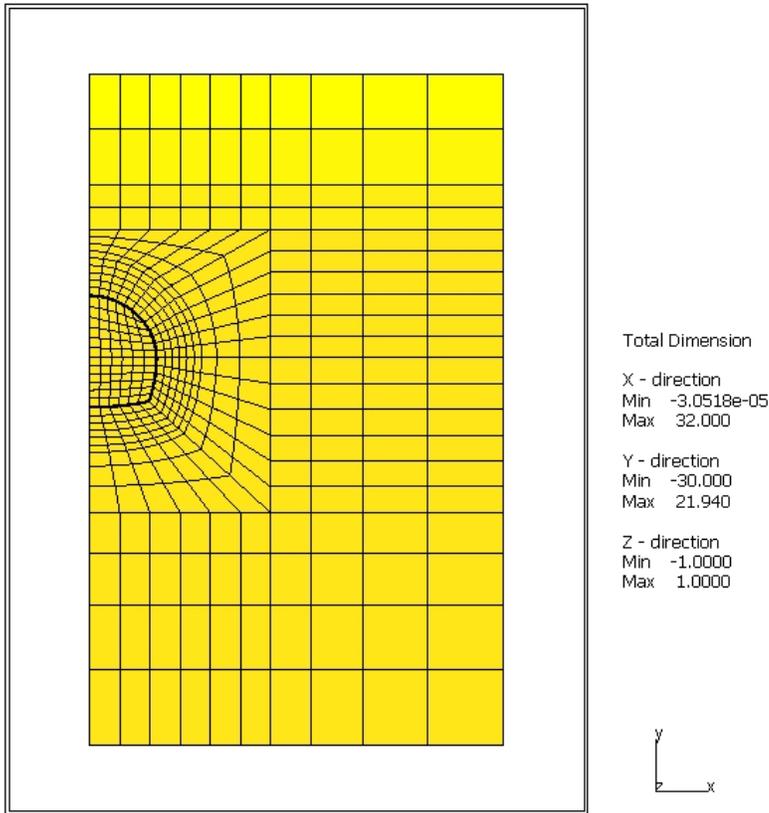
CONTINUUM ELEMENT INDEX

NEL	I	J	K	L	MATNO	IDH
1	2	1	8	9	4	0
2	3	2	9	10	4	0
3	4	3	10	11	4	0
4	5	4	11	12	4	0
5	6	5	12	13	4	0
6	7	6	13	14	4	0
-						
-						

458	489	488	499	500	4	0
459	490	489	500	501	4	0
460	491	490	501	502	4	0
461	492	491	502	503	4	0
462	493	492	503	504	4	0
463	494	493	504	505	4	0
464	495	494	505	506	4	0
0						

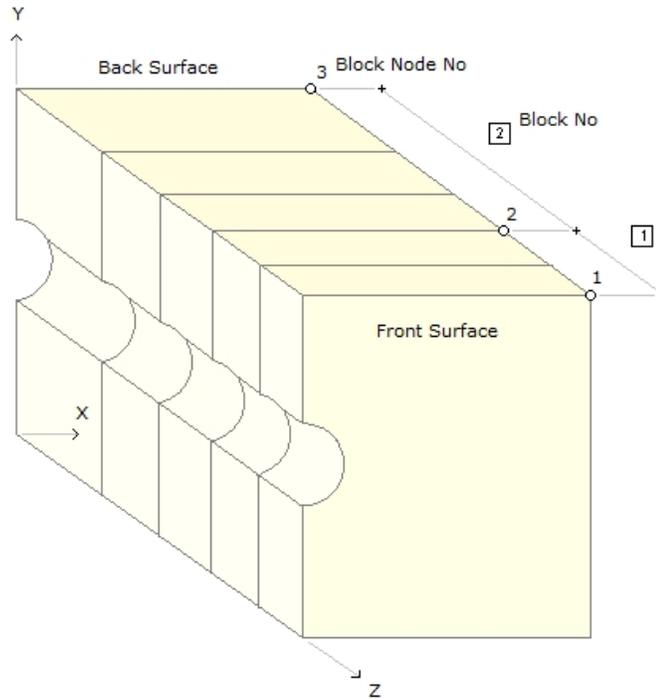
Table 7.22 Listing of input file Ex1.Dat for Example 1

```
* CARD 1.1
* TITLE
  3-D TUNNEL MESH GENERATION
* CARD 1.2
* NBZ  NBNODE
  2    3
* CARD 1.3
* IBZ_base IBZ_front IBZ_back
  0      3      3
* CARD 2.1
* NODE   ZP     XP
  1     60.    0
  2     41.    0
  3      0.    0
* =====
* CARD 3.1
* BLNAME
  BLOCK1
* IBLNO
  1
* CARD 3.3
* I   J   LTYPE
  1   2   0
* CARD 3.4
* NDZ   ALPA
  2     0.4
* =====
* CARD 3.1
* BLNAME
  BLOCK2
* IBLNO
  2
* CARD 3.3
* I   J   LTYPE
  2   3   0
* CARD 3.4
* NDZ   ALPA
  3     0.4
* =====
* CARD 4.1
* ITRANB
  0
* END OF DATA
```



EX1-2D.Mes

Figure 7.50 Finite element meshes representing typical 2D section



IPLANE = 0 (Input 2D section in X-Y plane)

For Block No 1, I = 1 J = 2 NDZ = 2  $\alpha = 0.4$

For Block No 2, I = 2 J = 3 NDZ = 3  $\alpha = 0.4$

Total Number of Blocks, NBZ = 2

Total Number of Block Nodes, NBNODE = 3

Figure 7.51 Schematic section view of 3D extension

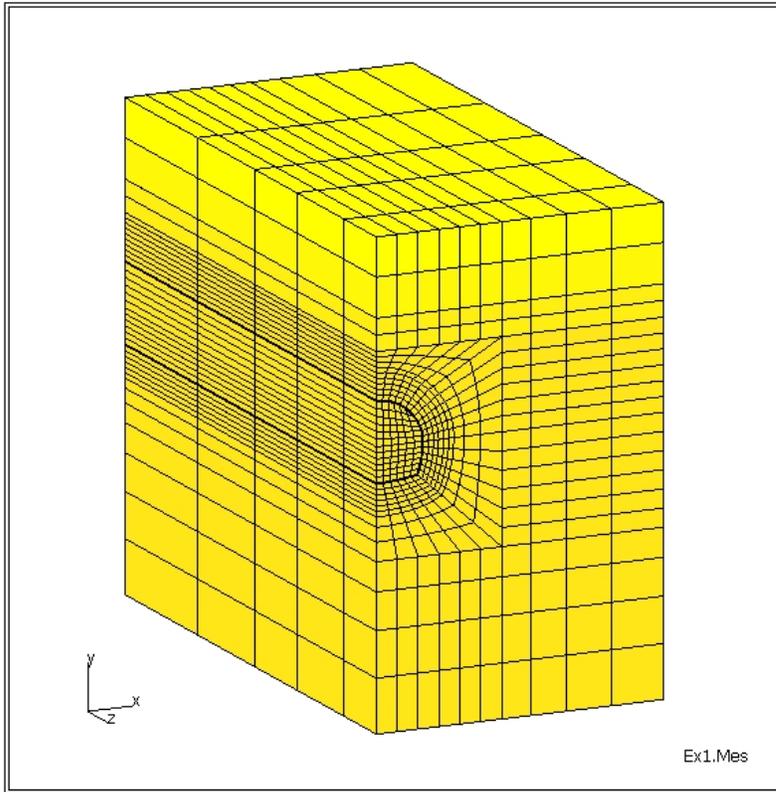
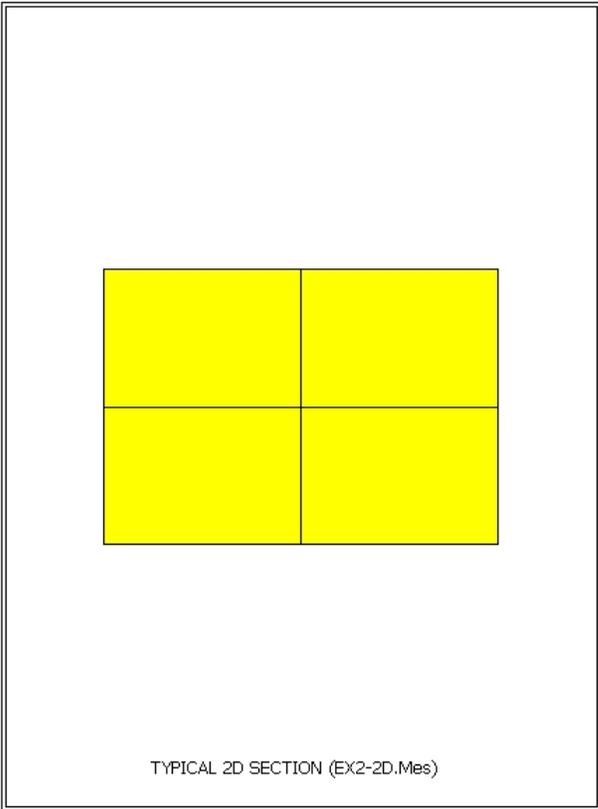


Figure 7.52 Generated 3D finite element mesh

## 7.6.2 Example 2: 3-D Curved Tunnel

Table 7.23 Listing of input file Ex2.Dat for Example 2

```
* CARD 1.1
* TITLE
  3-D CURVED TUNNEL
* CARD 1.2
* NBZ  NBNODE
  2    3
* CARD 1.3
* IBZ_base IBZ_front IBZ_back
  0      3      3
* CARD 2.1
* NODE   Zp      Xp
  1      0.0    16.30
  2     -6.238  15.06
  3     -42.60   0.00
*=====
* CARD 3.1
* BLNAME
  BLOCK1
* IBLNO
  1
* I   J   LTYPE
  1  2   1
* CARD 3.4
* NDZ,  ALPA
  4     0.5
* CARD 3.5
* Zo    Xo    R    Tb    Te
  0.0   0.0   16.3  0.0   22.5
*=====
* BLNAME
  BLOCK2
* IBLNO
  2
* I   J   LTYPE
  2  3   0
* NDZ,  ALPA
  8     0.3
*=====
* CARD 4.1
* ITRANB
  0
* END OF DATA
```



Total Dimension

X - direction  
Min 11.300  
Max 21.300

Y - direction  
Min 0  
Max 7.0000

Z - direction  
Min -1.0000  
Max 1.0000



Figure 7.53 Typical 2D section for Example 2

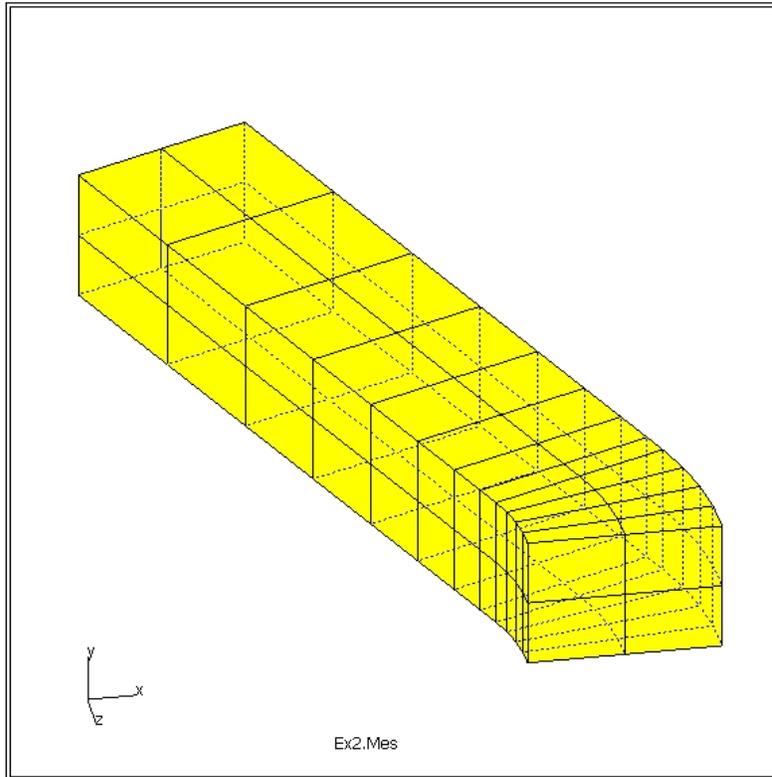


Figure 7.54 Generated 3D mesh for Example 2

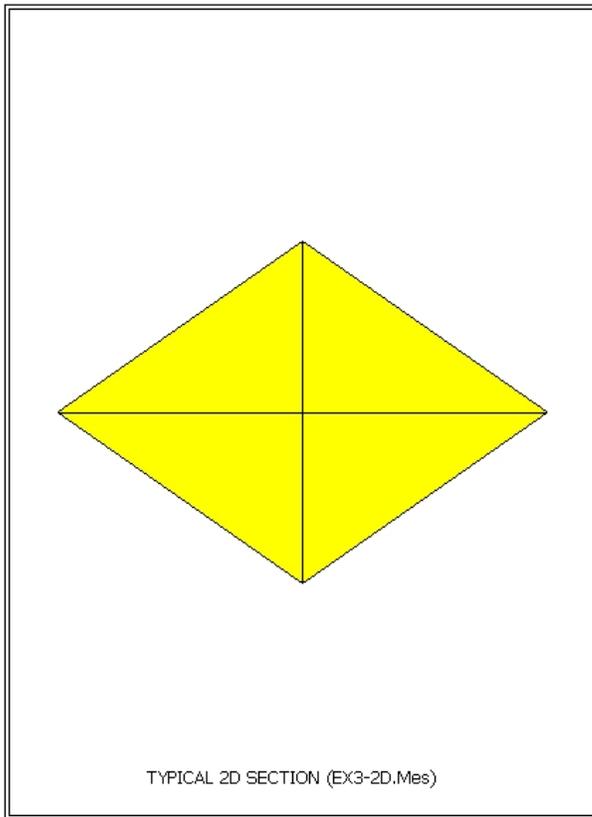
### 7.6.3 Example 3: 3-D Tunnel with Prism Elements

Table 7.24 Listing of input file Ex3.Dat for Example 3

```

* CARD 1.1
* TITLE
  3-D TUNNEL WITH PRISM ELEMENTS
* CARD 1.2
* NBZ  NBNODE
  2    3
* CARD 1.3
* IBZ_base IBZ_front IBZ_back
  0    3    3
* CARD 2.1
* NODE   Zp    Xp
  1     0.0   16.30
  2    -6.238 15.06
  3   -42.60  0.00
*=====
* CARD 3.1
* BLNAME
  BLOCK1
* IBLNO
  1
* I   J   LTYPE
  1   2   1
* CARD 3.4
* NDZ,  ALPA
  4     0.5
* CARD 3.5
* Zo    Xo    R    Tb    Te
  0.0   0.0   16.3  0.0   22.5
*=====
* BLNAME
  BLOCK2
* IBLNO
  2
* I   J   LTYPE
  2   3   0
* NDZ  ALPA
  8     0.3
*=====
* CARD 4.1
* ITRANB
  0
* END OF DATA

```



Total Dimension

X - direction  
Min 11.300  
Max 21.300

Y - direction  
Min 0  
Max 7.0000

Z - direction  
Min -1.0000  
Max 1.0000



Figure 7.55 Typical 2D section for Example 3

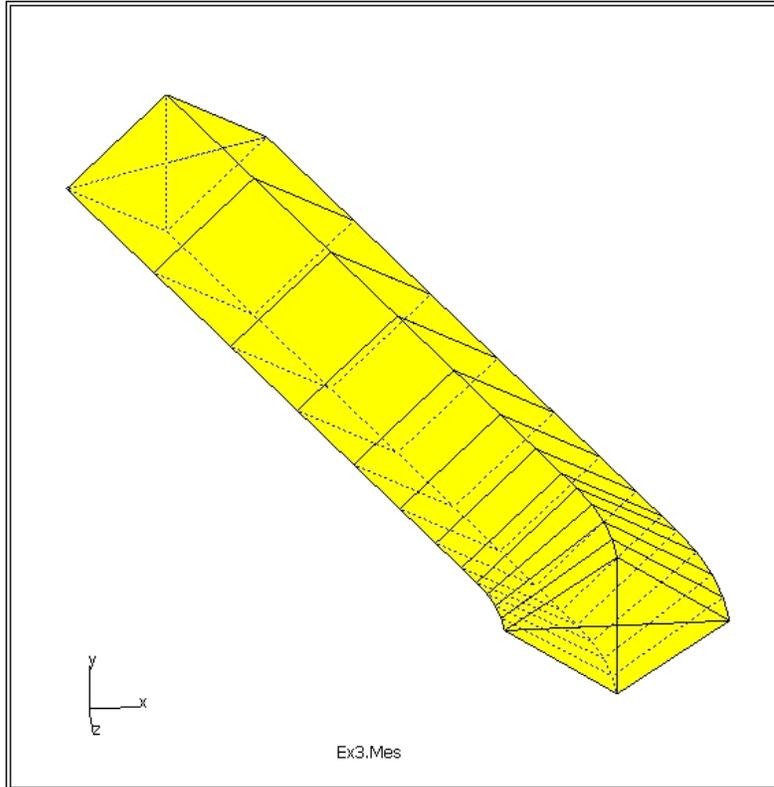


Figure 7.56 Generated 3D mesh for Example 3

### 7.6.4 Example 4: 3-D Pile Foundation

Table 7.25 Listing of input file Ex4.Dat for Example 4

```

* CARD 1.1
* TITLE
  3-D PILE FOUNDATION
* CARD 1.2
* NBZ  NBNODE  NSNODE  NSNEL  IBOUND  IPLANE  ICLOSE  CMFAC
   5     6       1       1       0       2       0       1.0
* IBZ_base IBZ_front IBZ_back
   0       3       3
* CARD 2.1
* NODE   Zp      Xp
   1     20.00   0
   2     19.50   0
   3     12.50   0
   4     12.25   0
   5     12.00   0
   6      0.00   0
*=====
* CARD 3.1
* BLNAME
  BLOCK1
* IBLNO
  1
* CARD 3.3
* I   J   LTYPE  IMATC  IMATB  IMATT
  1   2   0       0       0       0
* CARD 3.4
* NDZ  ALPA  MC1  MC2  MC3  MB  MT
   1    0.5  -1  -4  -5   0   0
*=====
* CARD 3.1
* BLNAME
  BLOCK2
* IBLNO
  2
* CARD 3.3
* I   J   LTYPE  IMATC  IMATB  IMATT
  2   3   0       0       0       0
* CARD 3.4
* NDZ  ALPA  MC1  MC2  MC3  MB  MT
  14   0.5   0   0   0   0   0
*=====

```

```

* CARD 3.1
* BLNAME
BLOCK3
* IBLNO
3
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT
3 4 0 1 0 0
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
1 0.5 3 4 5 0 0
=====
* CARD 3.1
* BLNAME
BLOCK4
* IBLNO
4
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT
4 5 0 1 0 0
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
1 0.5 3 4 0 0 0
=====
* CARD 3.1
* BLNAME
BLOCK5
* IBLNO
5
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT
5 6 0 6 0 0
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
8 0.3 -3 -5 0 0 0
=====
* CARD 4.1
* ITRANB
0
* END OF DATA

```

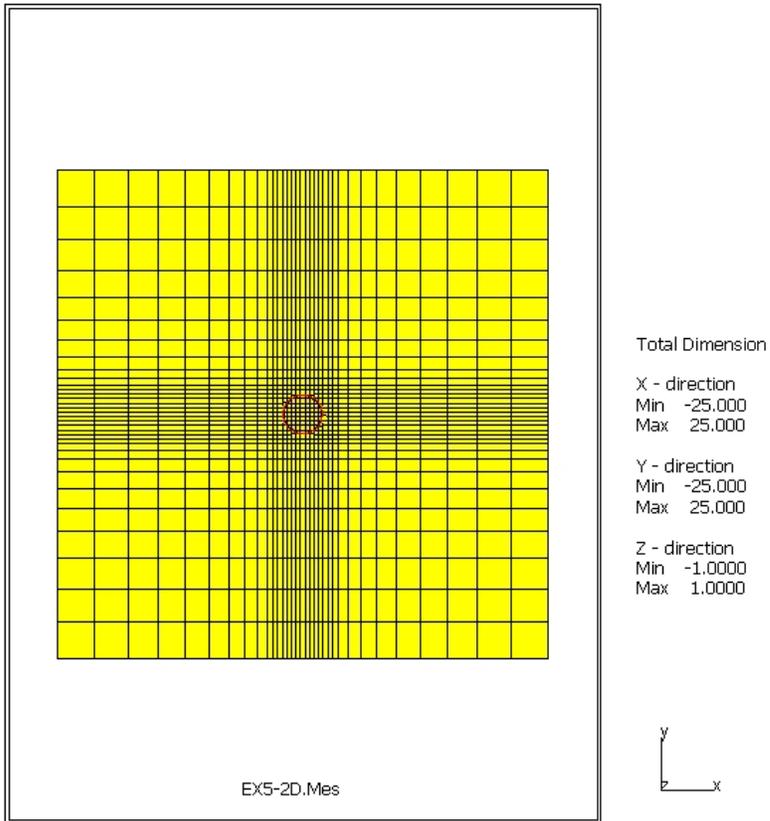


Figure 7.57 Typical 2D section for Example 4

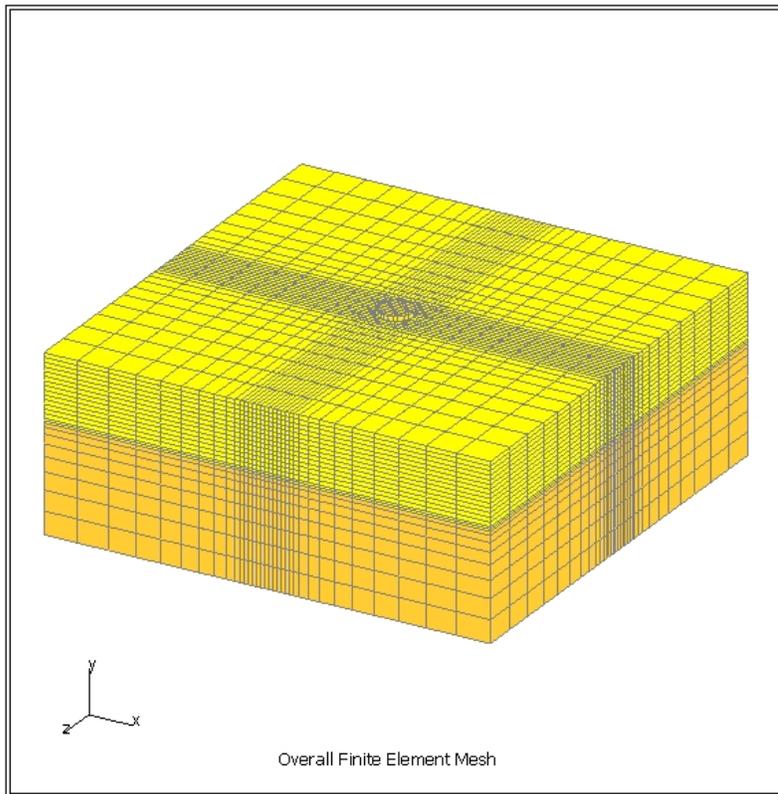


Figure 7.58 Generated 3D mesh for Example 4

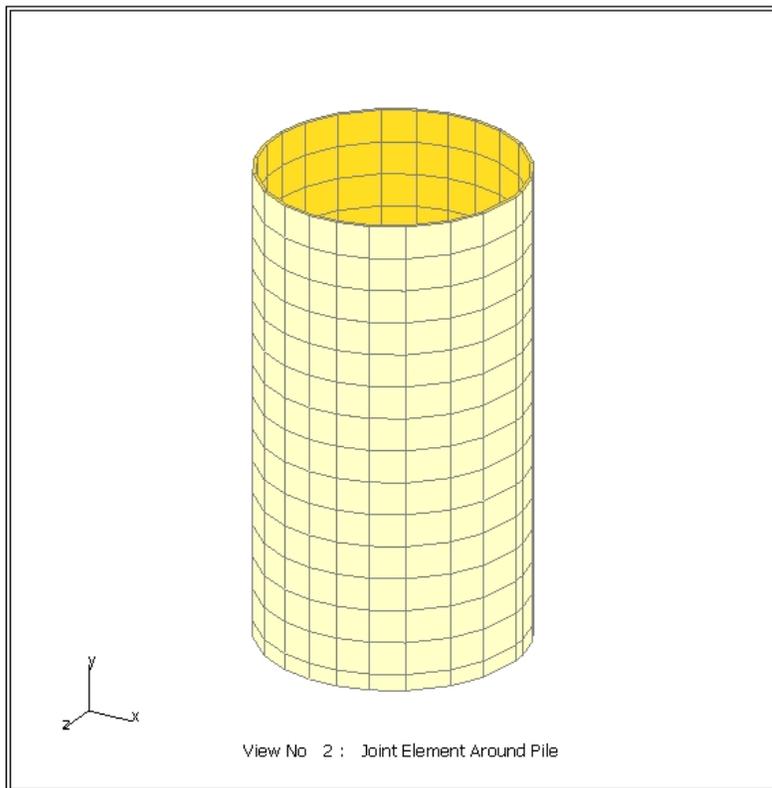


Figure 7.59 Generated joint element for Example 4

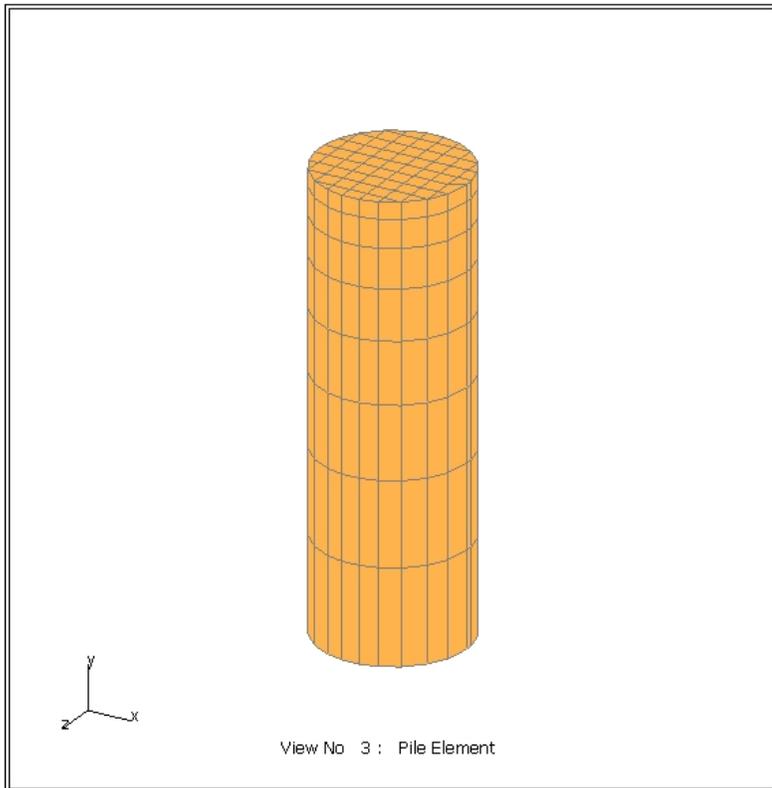


Figure 7.60 Generated pile element for Example 4

### 7.6.5 Example 5: Pile Foundation Using CIRCLE-2D

Table 7.26 Listing of input file Ex5.Dat for Example 5

```

* CARD 1.1
* TITLE
  FILE FOUNDATION USING CIRCLE-2D (CIR2F_QT.MES)
* CARD 1.2
* NBZ  NBNODE  NSNODE  NSNEL  IBOUND  IPLANE  ICLOSE  CMFAC
   5     6       1       1       0       2       0       1.0
* IBZ_base IBZ_front IBZ_back
   0     3       3
* CARD 2.1
* NODE   Zp      Xp
   1    20.00   0
   2    19.50   0
   3    12.50   0
   4    12.25   0
   5    12.00   0
   6     0.00   0
=====
* CARD 3.1
* BLNAME
  BLOCK1
* IBLNO
  1
* CARD 3.3
* I   J   LTYPE  IMATC  IMATB  IMATT  NIXCH
  1   2   0       0       0       0       2
* CARD 3.4
* NDZ  ALPA  MC1  MC2  MC3  MB  MT
   1    0.5  -1   -5   0   0   0
* CARD 3.6
* MATNO  NEWNO  NI1  NI2  NI3  NI4  NI5  NI6  NI7  NI8
   3     2
   4     3
=====

```

```

* CARD 3.1
* BLNAME
BLOCK2
* IBLNO
2
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT NIXCH
2 3 0 0 0 0 3
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
14 0.5 0 0 0 0 0
* CARD 3.6
* MATNO NEWNO NI1 NI2 NI3 NI4 NI5 NI6 NI7 NI8
1 8
3 2
5 5
=====
* CARD 3.1
* BLNAME
BLOCK3
* IBLNO
3
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT NIXCH
3 4 0 0 0 0 4
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
1 0.5 0 0 0 0 0
* CARD 3.6
* MATNO NEWNO NI1 NI2 NI3 NI4 NI5 NI6 NI7 NI8
1 9 0 0 0 0 1010 1010 1010 1010
3 2 0 0 0 0 0 0 0 0
4 4 0 0 0 0 1010 1010 0 0
5 6 0 0 0 0 1010 1010 1010 1010
=====

```

## 7-112 GEN-3D Example Problem

```
* CARD 3.1
* BLNAME
BLOCK4
* IBLNO
4
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT NIXCH
4 5 0 0 0 0 2
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
1 0.5 -1 -4 -5 0 0
* CARD 3.6
* MATNO NEWNO NI1 NI2 NI3 NI4 NI5 NI6 NI7 NI8
2 -1
3 -1 0 0 0 0 25 25 0 0
=====
* CARD 3.1
* BLNAME
BLOCK5
* IBLNO
5
* CARD 3.3
* I J LTYPE IMATC IMATB IMATT NIXCH
5 6 0 0 0 0 2
* CARD 3.4
* NDZ ALPA MC1 MC2 MC3 MB MT
8 0.3 -2 -3 -4 0 0
* CARD 3.6
* MATNO NEWNO NI1 NI2 NI3 NI4 NI5 NI6 NI7 NI8
1 7
5 7
=====
* CARD 4.1
* ITRANB
0
* END OF DATA
```

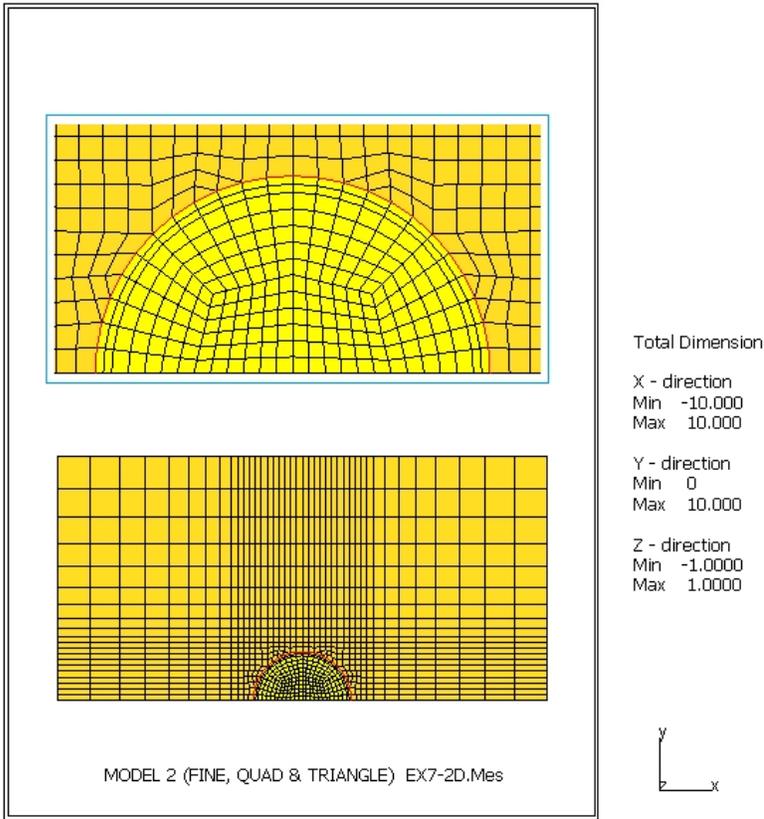


Figure 7.61 Typical 2D section for Example 5

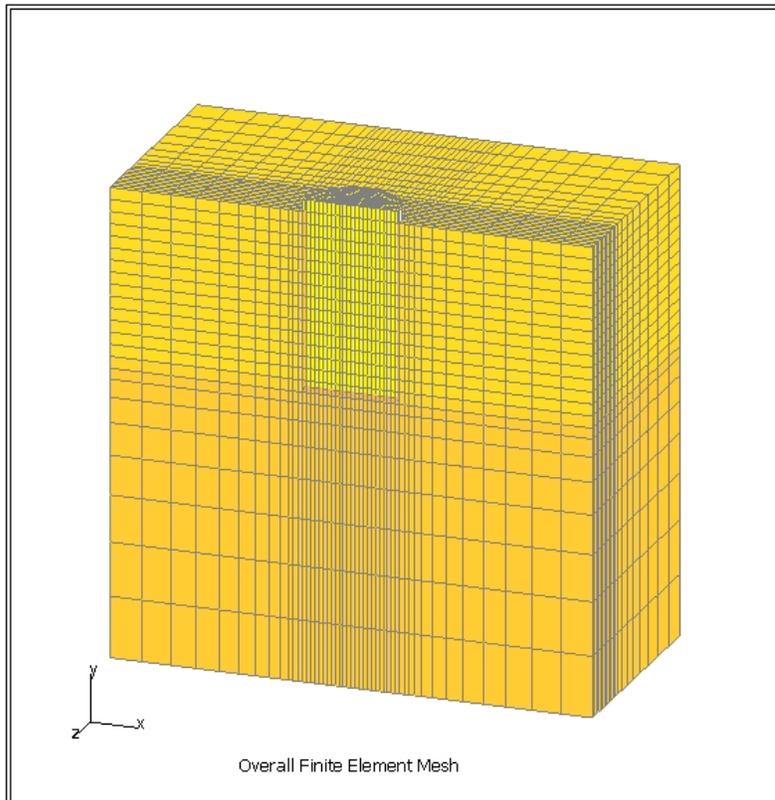


Figure 7.62 Generated 3D mesh for Example 5

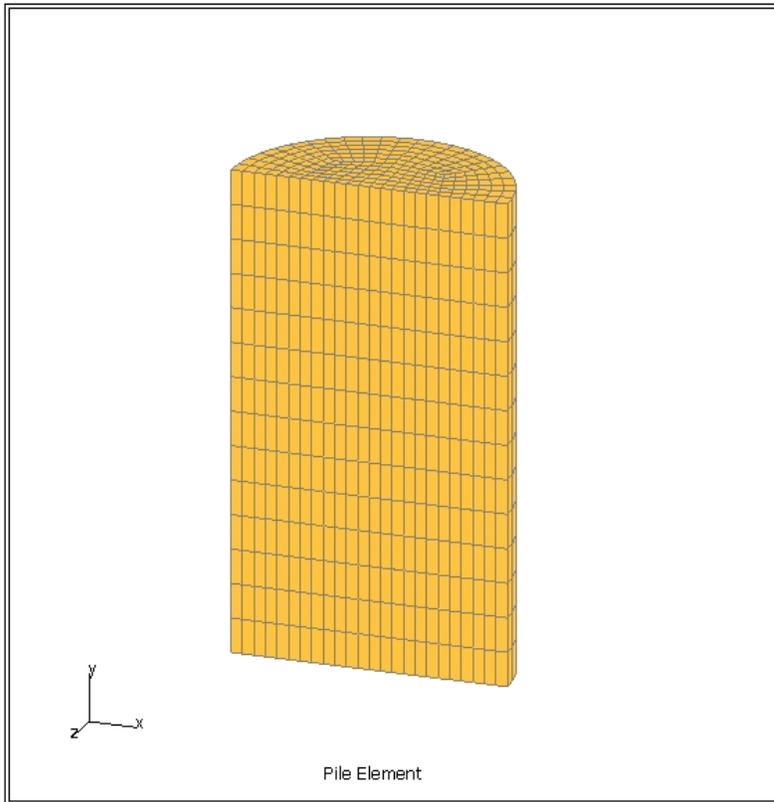


Figure 7.63 Generated pile element for Example 5



## 7.7 PRESMAP-GP

PRESMAP-GP is the general purpose pre-processor which can be used to generate coordinates, element indexes, and boundary codes of various geometries modeled by truss, beam, shell or continuum elements. Input parameters of PRESMAP-GP have been described in detail in Section 7.9 of User's Manual.

Input file for PRESMAP-GP is also called block mesh file which can be generated or modified by [Block Mesh Generator](#) described in Section 6 of User's Manual.

PRESMAP-GP can be selected in the following order.

Run → Mesh Generator → PreSmap → Presmap GP

When you finish the execution of PRESMAP-GP, select [PLOT-3D](#) to plot the generated mesh.

### 7.7.1 Example 1: 3-D Line/Surface/Volume Blocks

Example 1 shows you how Beam, Shell and Continuum elements are generated using various types of blocks. There are a total of 5 blocks consisting of a line block, a triangle surface block, and a quad surface block, a prism volume block, and a hexahedron volume block. Detailed block information is listed in Table 7.27.

Input block meshes and generated finite element meshes are presented in the following order:

#### Input Block Meshes

- Figure 7.64 Node and block numbers
- Figure 7.65 Block numbers for line and surface blocks
- Figure 7.66 Material numbers for line and surface blocks
- Figure 7.67 Block numbers for volume blocks
- Figure 7.68 Material numbers for volume blocks
- Figure 7.69 Water flow boundary codes
- Figure 7.70 Function time history numbers
- Figure 7.71 Initial total head

**Generated Finite Element Meshes**

- Figure 7.72 Node and element numbers
- Figure 7.73 Element numbers for beam and shell elements
- Figure 7.74 Material numbers for beam and shell elements
- Figure 7.75 Element numbers for continuum elements
- Figure 7.76 Material numbers for continuum elements
- Figure 7.77 Water flow boundary codes
- Figure 7.78 Function time history numbers
- Figure 7.79 Initial total head

**Table 7.27 Listing of input file EX1.Meb**

```

StartPresmap
VersionNo = 7.000
* CARD 1.1
* TITLE
  3-D LINE/SURFACE/VOLUME ELEMENT GENERATION
* CARD 1.2
* NBLOCK   NBNODE   NSNODE   NSNEL   IGBND   ISMAP   CMFAC   ICOMP
  5         12      1         1       0       10      1.000   1
=====
* CARD 1.3
* Global Outer Surface Boundary
* X - Right Boundary
* ITG      IDF          H          CF
  2         7          7.000000E-001  7.700000E+000
* X - Left Boundary
* ITG      IDF          H          CF
  0         0          0.000000E+000  0.000000E+000
* Y - Top Boundary
* ITG      IDF          H          CF
  0         0          0.000000E+000  0.000000E+000
* Y - Bottom Boundary
* ITG      IDF          H          CF
  0         0          0.000000E+000  0.000000E+000
* Z - Front Boundary
* ITG      IDF          H          CF
  0         0          0.000000E+000  0.000000E+000
* Z - Back Boundary
* ITG      IDF          H          CF
  0         0          0.000000E+000  0.000000E+000
=====

```

```
* CARD 1.4
* Automatic Finite Element Generation Control Parameters
* Min Length      Max Element
  1.000          10000
=====
* CARD 2.1
* NODE  X          Y          Z
  1      4.0        6.5        0.0
  2      0.0        2.0        0.0
  3      5.9        0.8        0.0
  4      7.0        7.0        0.0
  5      7.0        1.0        0.0
  6      5.72       3.87       0.0
  7      4.0        6.5       -1.0
  8      0.0        2.0       -1.0
  9      5.9        0.8       -1.0
 10      7.0        7.0       -1.0
 11      7.0        1.0       -1.0
 12      5.72       3.87       -1.0
=====
StartBlock
  1
* CARD 3.1
* BLNAME
  BLOCK 1
* CARD 3.2
* ICOORD  IMODE  ILAG
  1      0      0
* CARD 3.3
* I1      I2
  1      3
* M3
  0
* M4
  0
* M5      M6      M7
  0      0      0
* CARD 3.4.1
* NBOUND
  1
* CARD 3.4.2
* IBTYPE ID      IDF      H          CF
  1      1      8      8.000000E-001  8.800000E+000
* CARD 3.5
* MATNO  NDX
  1      4
EndBlock
```

```

=====
StartBlock
* CARD 3.0
* IBETYPE
  -2
* CARD 3.1
* BLNAME
  BLOCK 2
* CARD 3.2
* ICOORD IMODE  ILAG
  1      0      1
* CARD 3.3
* I1      I2      I3
  1      2      3
* M4      M5      M6
  0      0      0
* M7
  0
* M8      M9      M10
  0      0      0
* CARD 3.4.1
* NBOUND
  1
* CARD 3.4.2
* IBTYPE ID      IDF      H      CF
  1      1      8      8.000000E-001  8.800000E+000
* CARD 3.5
* MATNO  NDXY
  4      4
* IDH
  0
EndBlock
=====
StartBlock
* CARD 3.0
* IBETYPE
  2
* CARD 3.1
* BLNAME
  BLOCK 3
* CARD 3.2
* ICOORD IMODE  ILAG
  1      0      1
* CARD 3.3
* I1      I2      I3      I4
  4      1      3      5

```

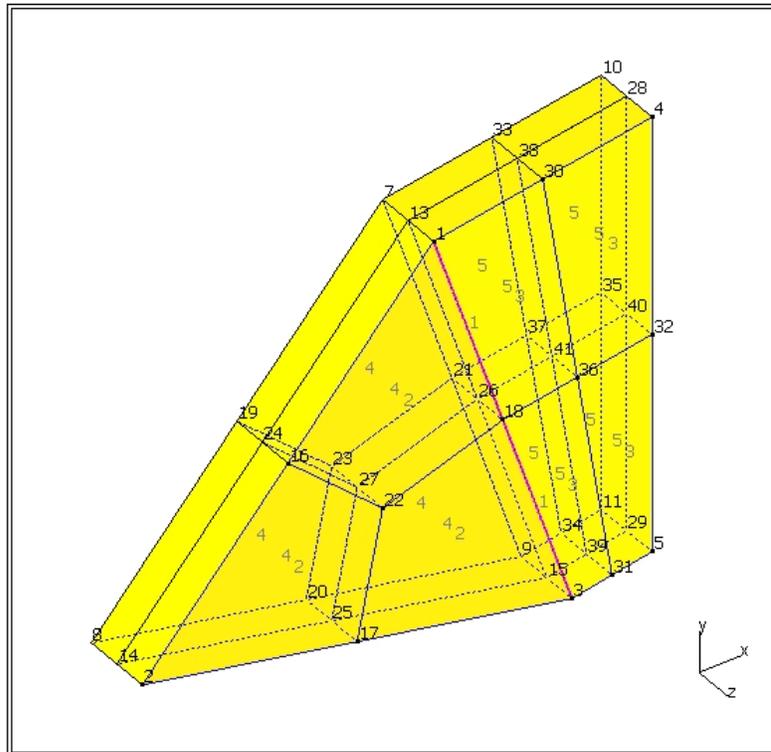
```

* M5      M6      M7      M8
  0       0       0       0
* M9
  0
* M10     M11     M12
  0       0       0
* CARD 3.4.1
* NBOUND
  1
* CARD 3.4.2
* IBTYPE ID      IDF      H          CF
  1       1      8      8.000000E-001  8.800000E+000
* CARD 3.5
* MATNO  NDX     NDY
  2       1      4
* NT1    NT2    NT3    NT4
  0       0      0      0
* MAT1   MAT2   MAT3   MAT4
  0       0      0      0
* IDH
  0
EndBlock
=====
StartBlock
* CARD 3.0
* IBETYPE
  -3
* CARD 3.1
* BLNAME
  BLOCK 4
* CARD 3.2
* ICOORD IMODE  ILAG
  1       0      1
* CARD 3.3
* I1    I2    I3    I4    I5    I6
  1     2     3     7     8     9
* M7    M8    M9    M10   M11   M12   M13   M14   M15   M16   M17
  0     0     0     0     0     0     0     0     0     0     0
* M18   M19   M20   M21
  0     0     0     0
* M22   M23   M24
  0     0     0
* CARD 3.4.1
* NBOUND
  1
* CARD 3.4.2
* IBTYPE ID      IDF H          CF
  1       1      8      8.000000E-001  8.800000E+000

```

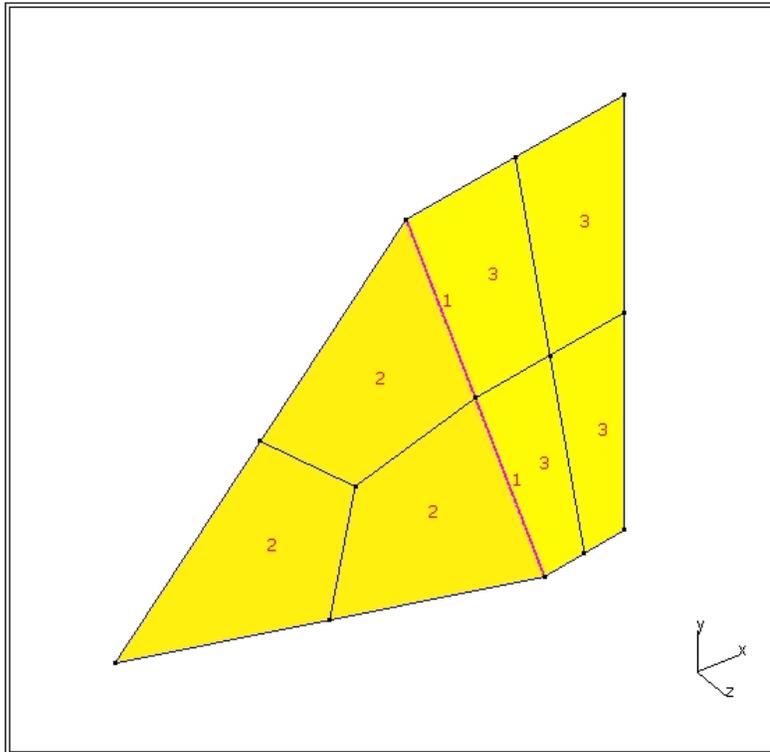
7-122 PRESMAP-GP Example Problem

```
* CARD 3.5
* MATNO  NDXY  NDZ  IDH
  1      4      1      0
EndBlock
=====
StartBlock
* CARD 3.0
* IBETYPE
  3
* CARD 3.1
* BLNAME
  BLOCK 5
* CARD 3.2
* ICOORD  IMODE  ILAG
  1      0      1
* CARD 3.3
* I1  I2  I3  I4  I5  I6  I7  I8
  4   1   3   5  10   7   9  11
* M9  M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20
  0   0   0   0   0   0   0   0   0   0   0   0
* M21 M22 M23 M24 M25 M26 M27
  0   0   0   0   0   0   0
* M28 M29 M30
  0   0   0
* CARD 3.4.1
* NBOUND
  1
* CARD 3.4.2
* IBTYPE ID  IDF  H  CF
  1   1   8   8.000000E-001  8.800000E+000
* CARD 3.5
* MATNO  NDX  NDY  NDZ  IDH
  3      1      4      1      0
* NT1  NT2  NT3  NT4
  0      0      0      0
* MAT1  MAT2  MAT3  MAT4
  0      0      0      0
EndBlock
=====
EndOfLastBlock
```



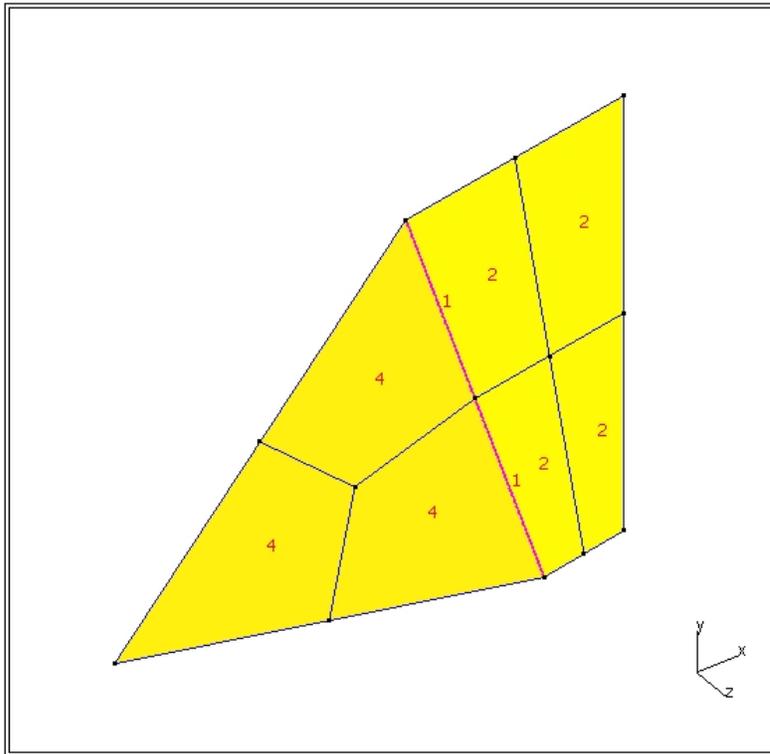
3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Node and Block Number

Figure 7.64 Node and block numbers for Example 1



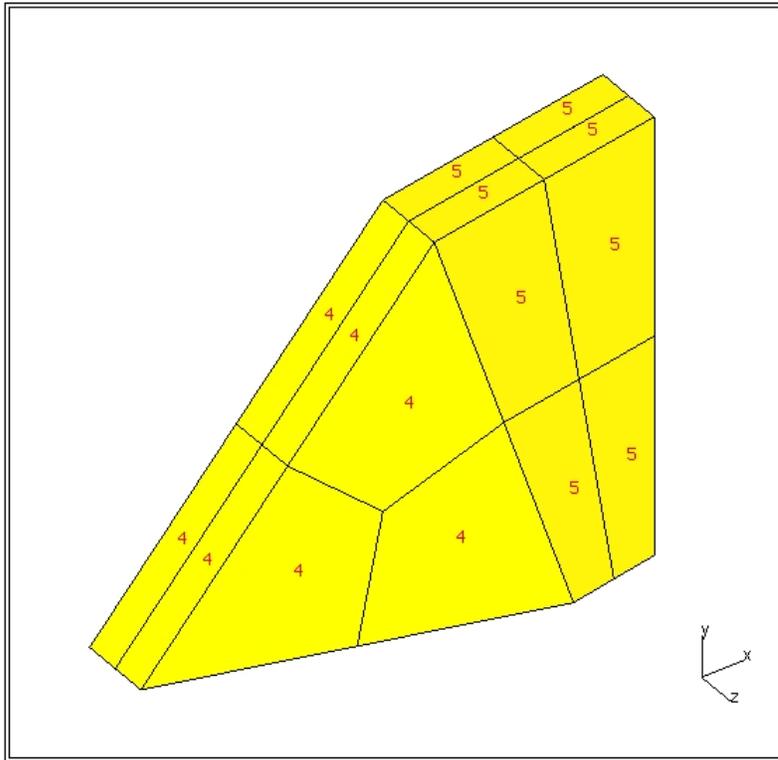
3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Block Number

Figure 7.65 Block numbers for line and surface blocks



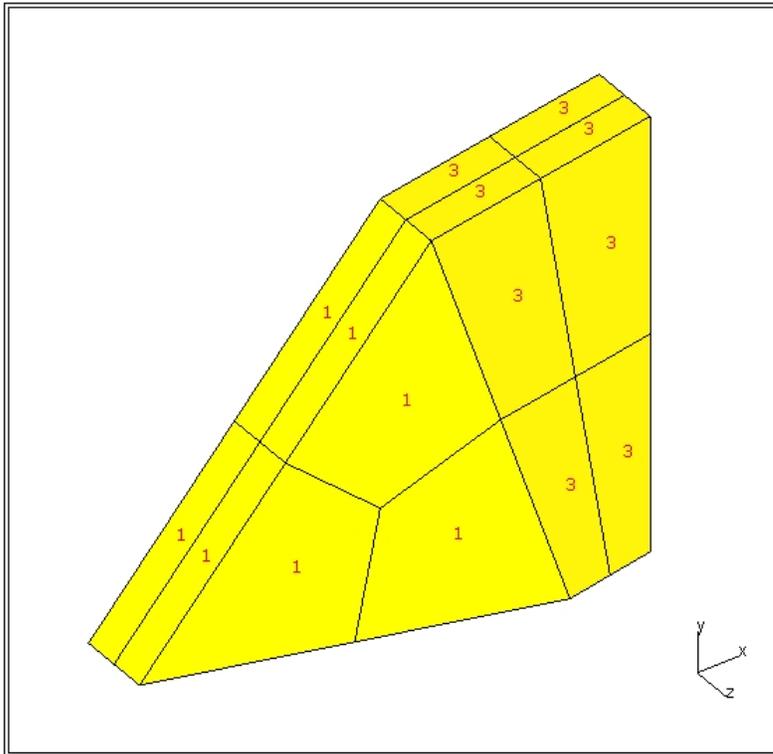
3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Material Number

Figure 7.66 Material numbers for line and surface blocks



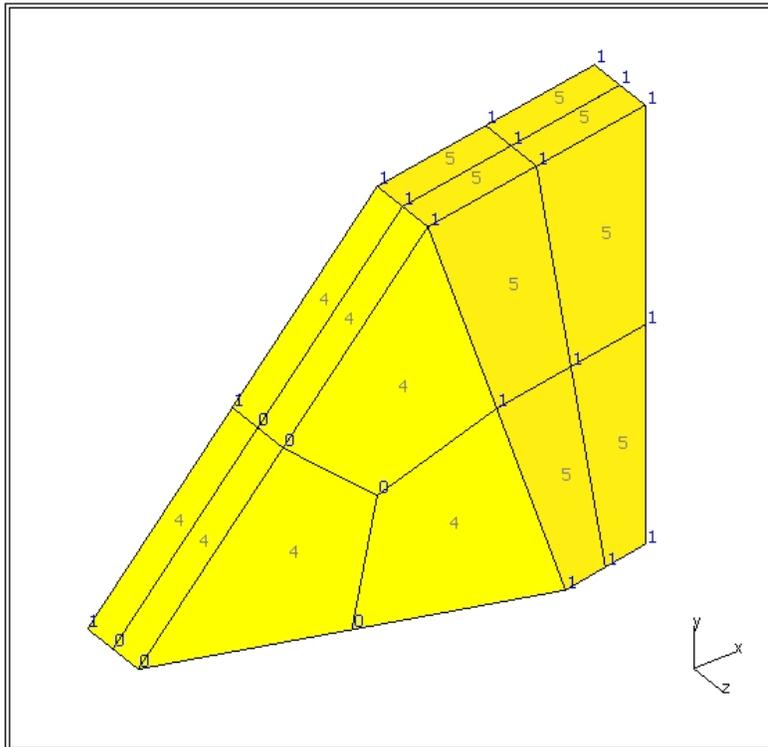
3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Block Number

Figure 7.67 Block numbers for volume blocks



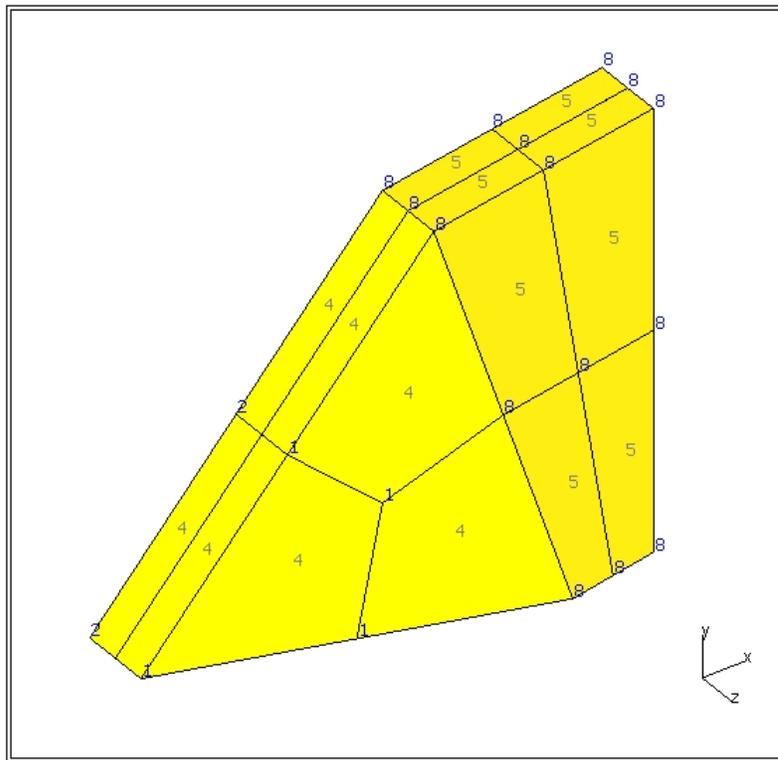
3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Material Number

Figure 7.68 Material numbers for volume blocks



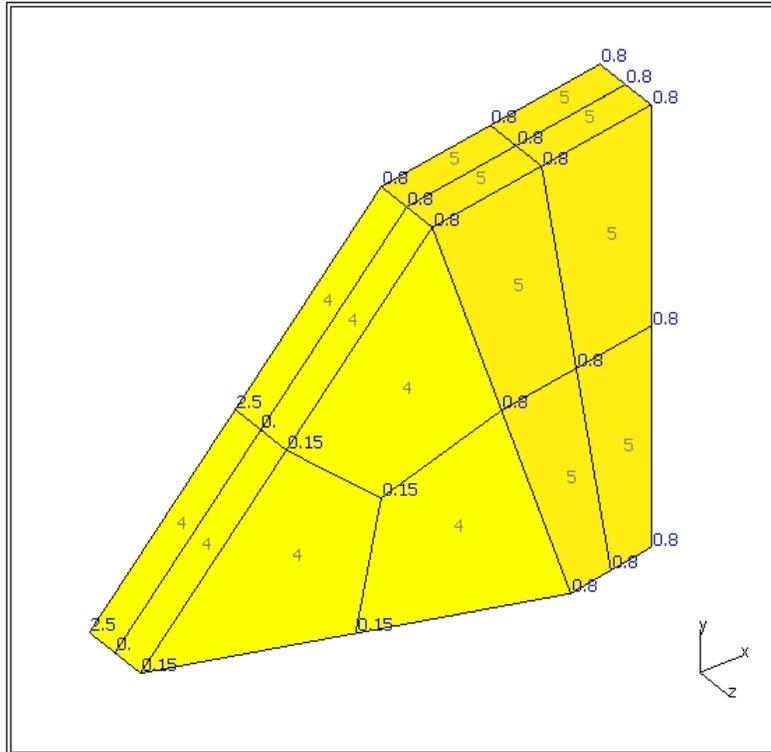
LINE/SURFACE/ ELEMENT GENERATION  
Water Flow (ID = 0), Total Head (ID = 1), Potential Seepage Face (ID = 3) Boundary Code

Figure 7.69 Water flow boundary codes



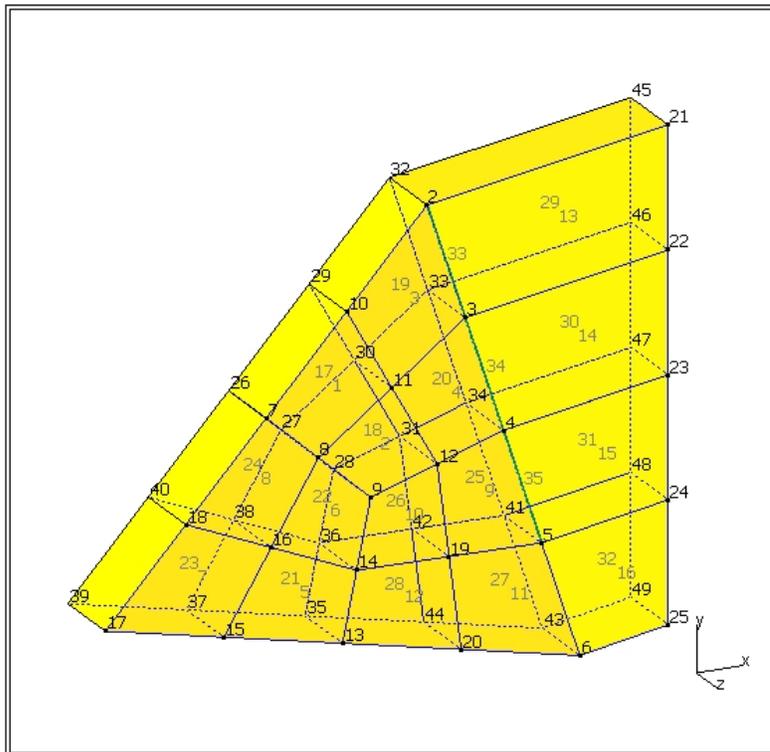
3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Function Time History No: IDF

Figure 7.70 Function time history numbers



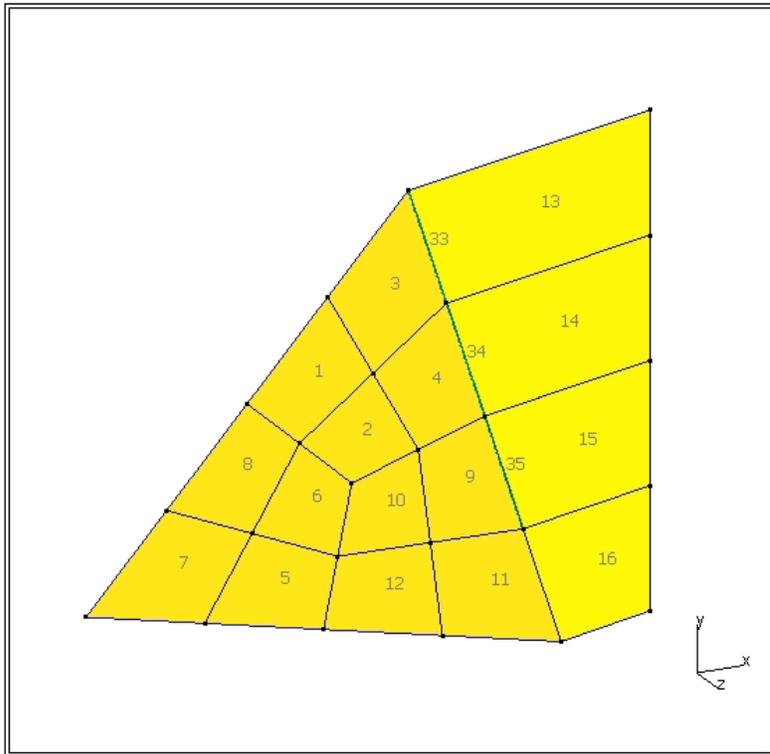
LINE/SURFACE/ ELEMENT GENERATION  
Initial Total Head: H

Figure 7.71 Initial total heads



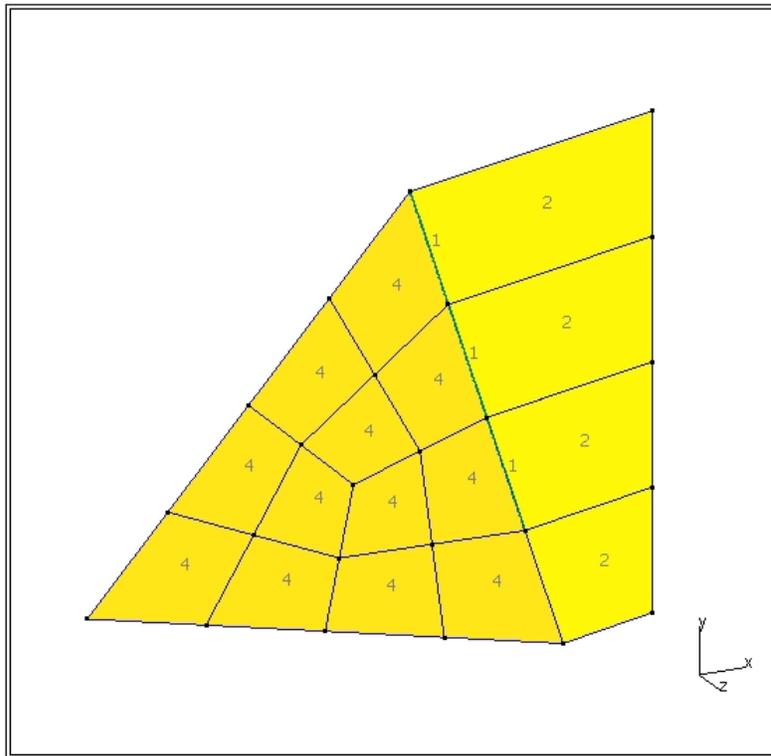
View No 1 : 3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Node and Element Number

Figure 7.72 Node and element numbers for Example 1



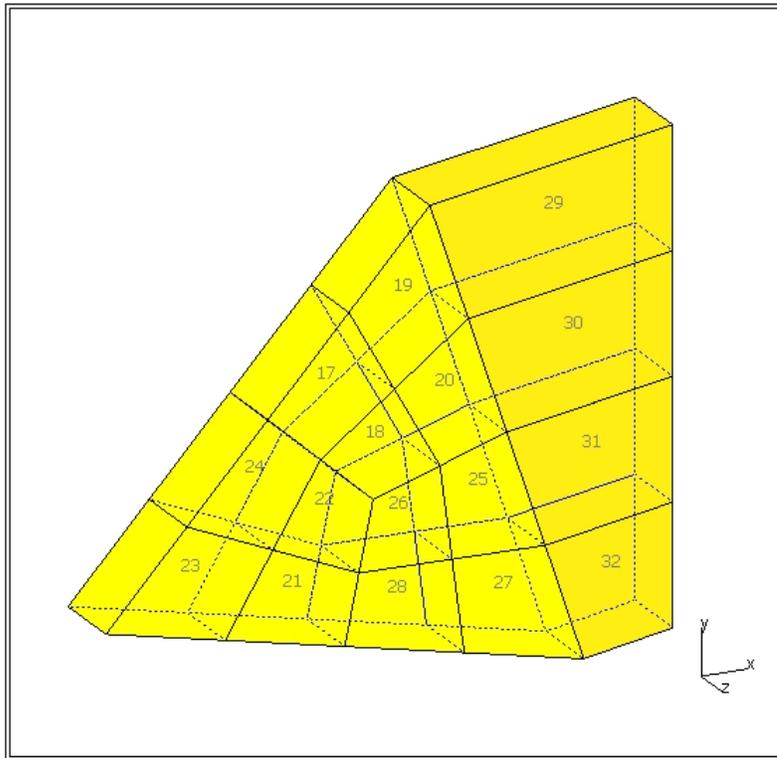
View No 1 : 3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Element Number

Figure 7.73 Element numbers for beam and shell elements



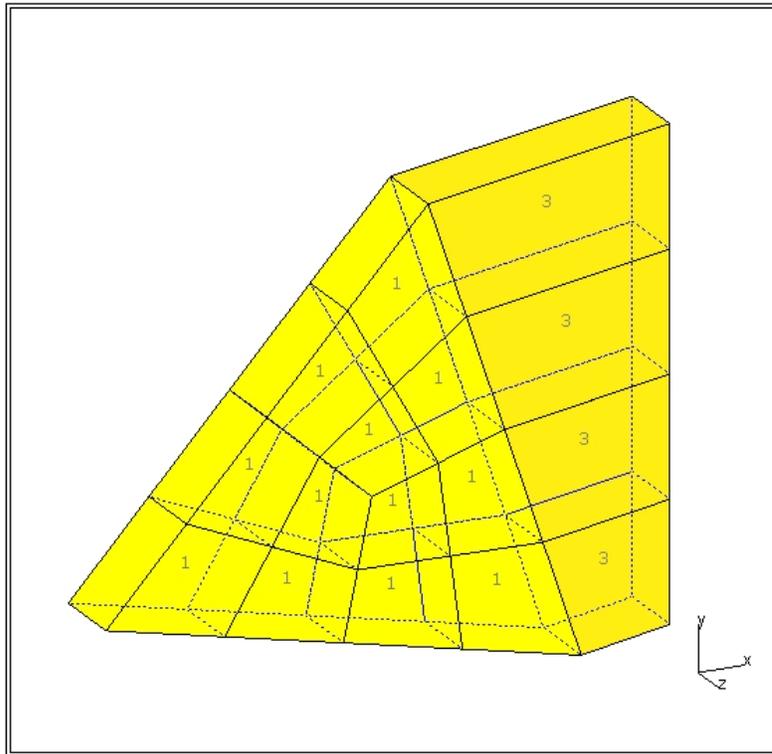
View No 1 : 3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Material Number

Figure 7.74 Material numbers for beam and shell elements



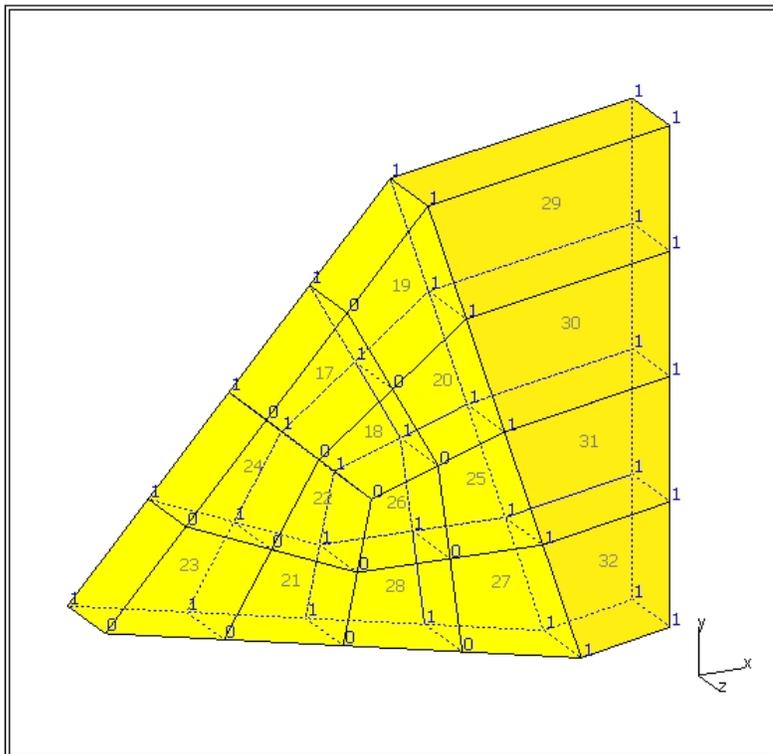
View No 1 : 3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Element Number

Figure 7.75 Element numbers for continuum elements



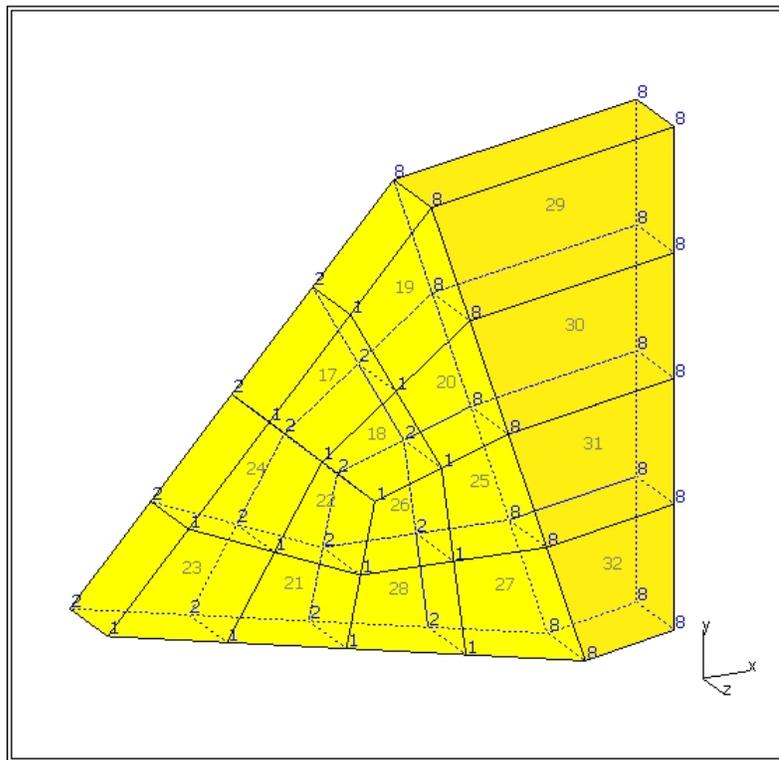
View No 1 : 3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Material Number

Figure 7.76 Material numbers for continuum elements



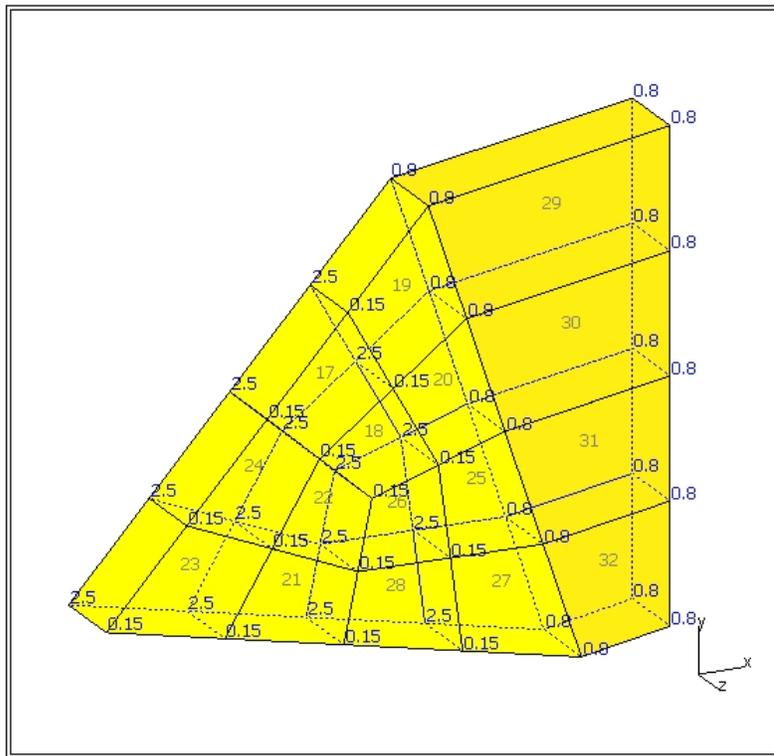
EX1.Mes  
Water Flow (ID = 0), Total Head (ID = 1), Potential Seepage Face (ID = 3) Boundary Code

Figure 7.77 Water flow boundary codes



View No. 1 : 3-D LINE/SURFACE/VOLUME ELEMENT GENERATION  
Function Time History No: IDF

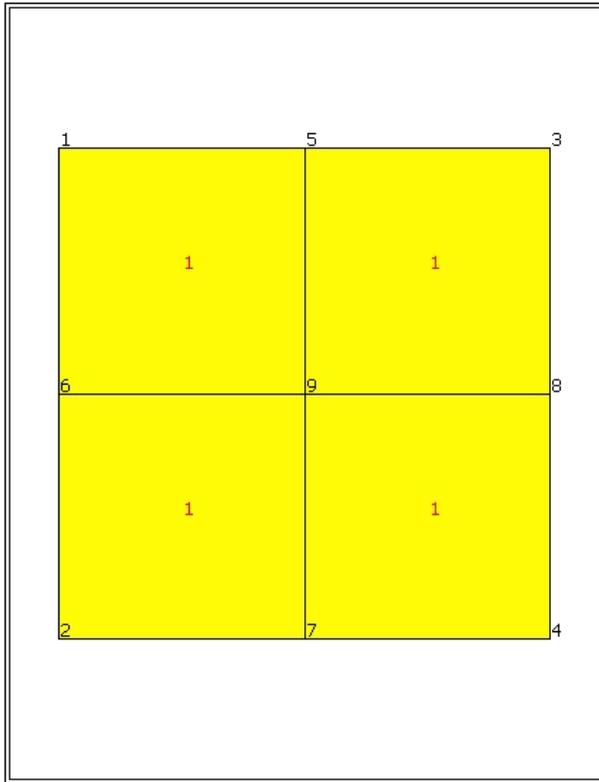
Figure 7.78 Function time history numbers



EX1.Mes  
Initial Total Head: H

Figure 7.79 Initial total heads

**7.7.2 Example 2: Surface with Corner Triangles**



Total Dimension

X - direction  
 Min 0  
 Max 10.000

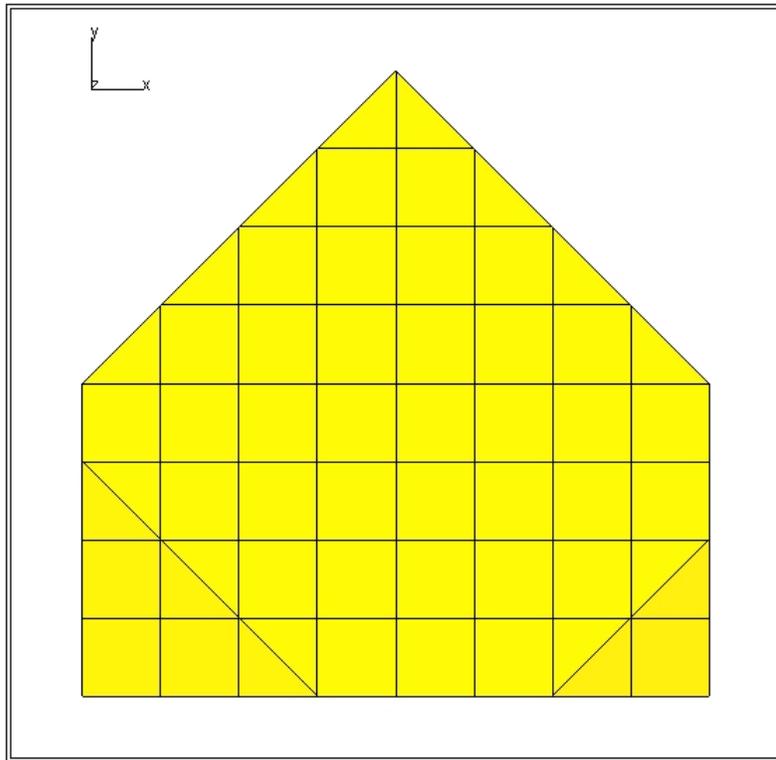
Y - direction  
 Min 0  
 Max 10.000

Z - direction  
 Min -1.0000  
 Max 1.0000



SURFACE ELEMENT GENERATION WITH CORNER TRIANGLES.  
 Node and Block Number

Figure 7.80 Block mesh for Example 2



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX2\EX2.Mes

Figure 7.81 Finite element mesh for Example 2

**7.7.3 Example 3: Circular Sector**

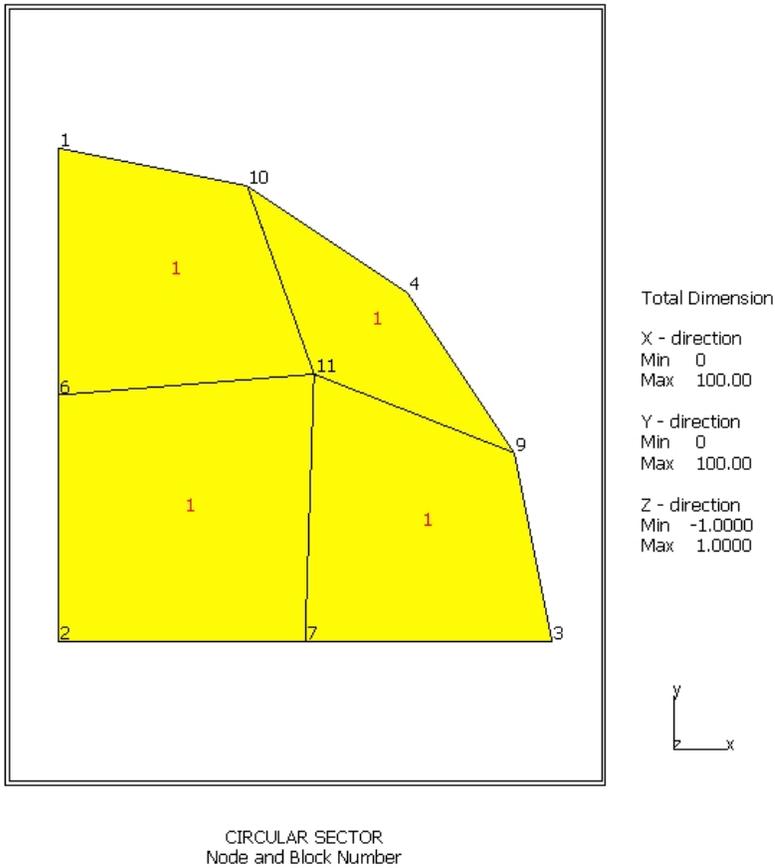
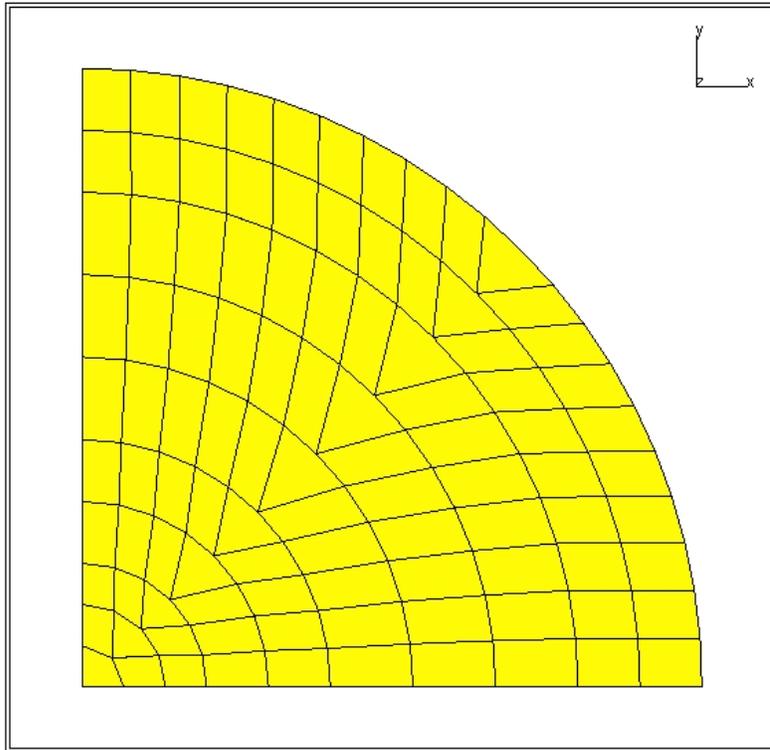


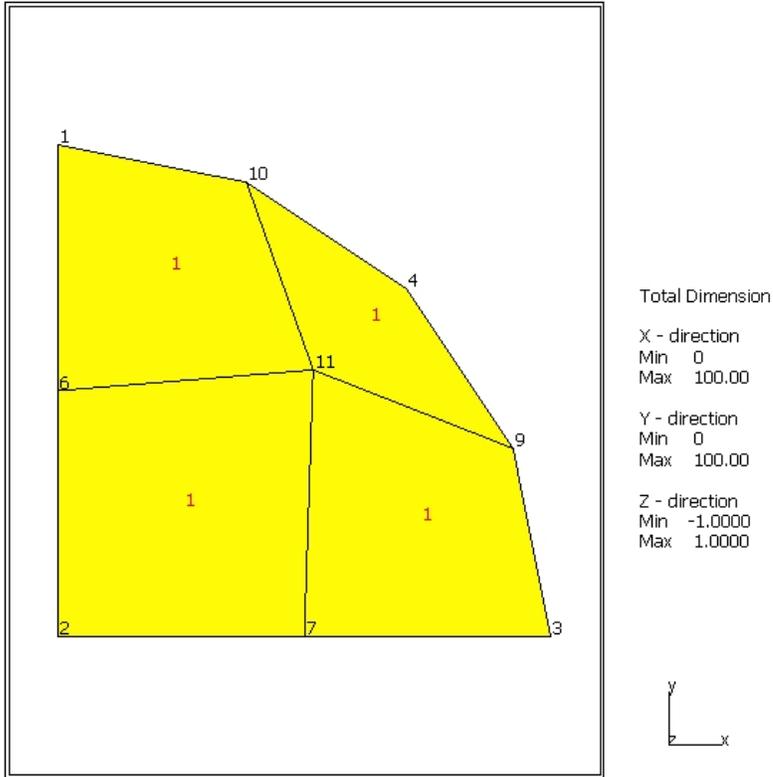
Figure 7.82 Block mesh for Example 3



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX3\EX3.Mes

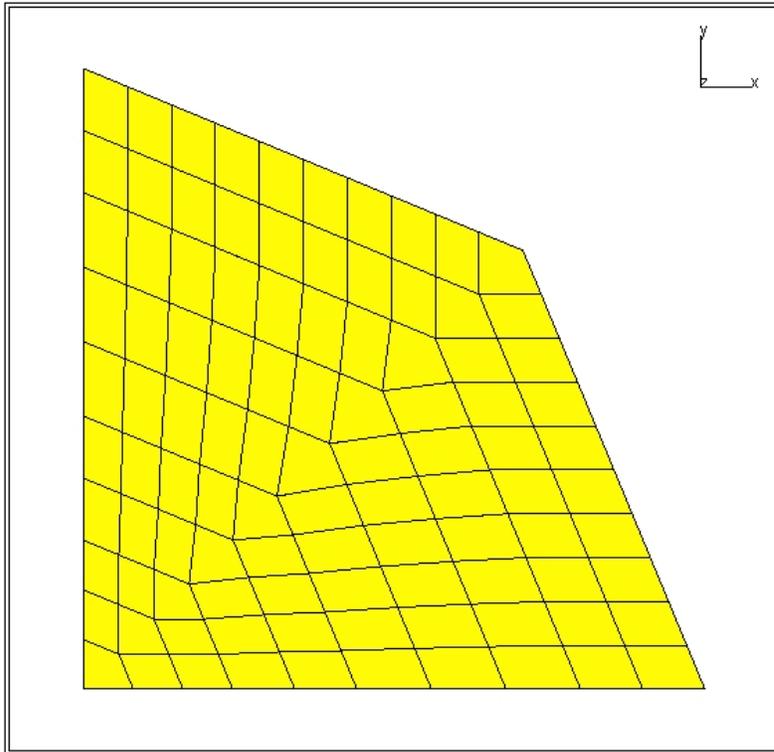
Figure 7.83 Finite element mesh for Example 3

**7.7.4 Example 4: Straight Line Sector**



STRAIGHT LINE SECTOR  
Node and Block Number

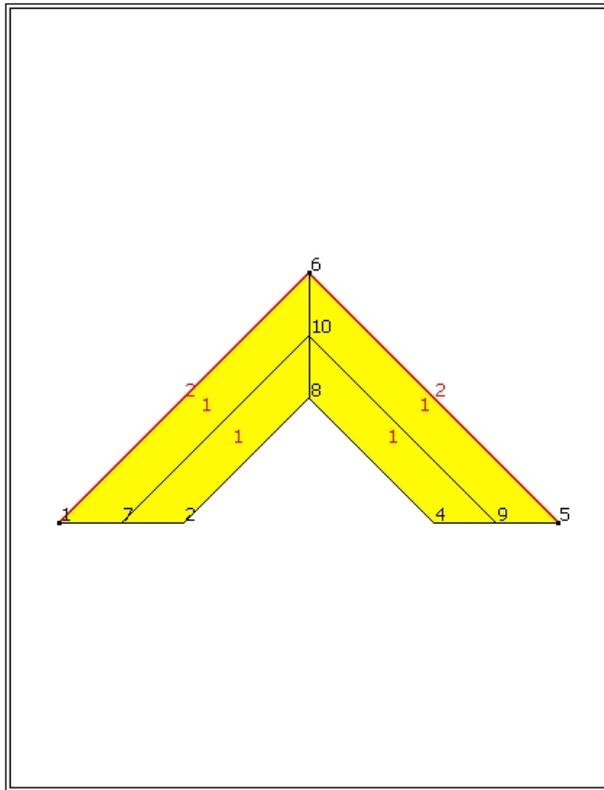
Figure 7.84 Block mesh for Example 4



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX4\EX4.Mes

Figure 7.85 Finite element mesh for Example 4

**7.7.5 Example 5: Surface and Line Element (1)**

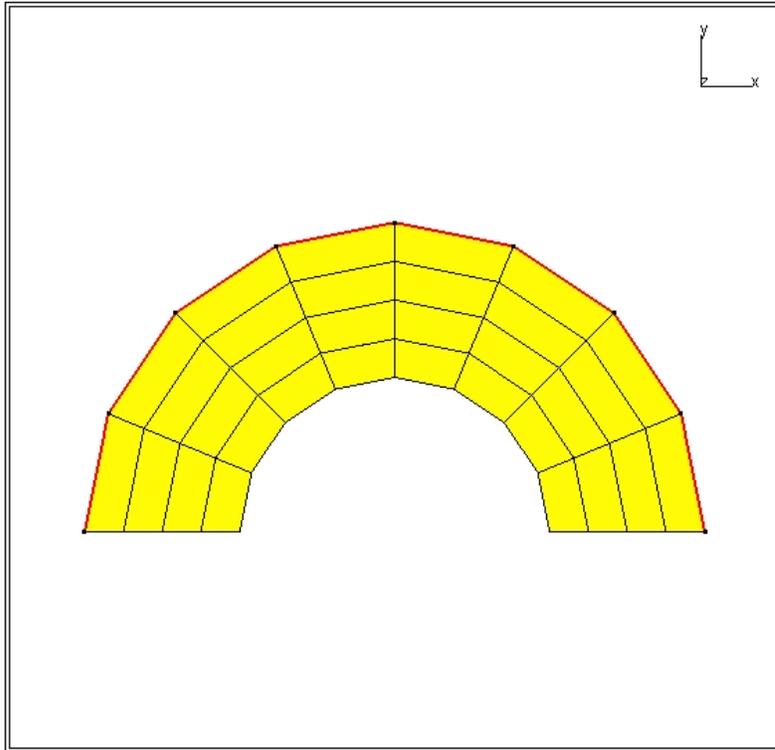


Total Dimension  
 X - direction  
 Min -10.000  
 Max 10.000  
 Y - direction  
 Min 0  
 Max 10.000  
 Z - direction  
 Min -1.0000  
 Max 1.0000



SURFACE AND LINE ELEMENT GENERATION  
 Node and Block Number

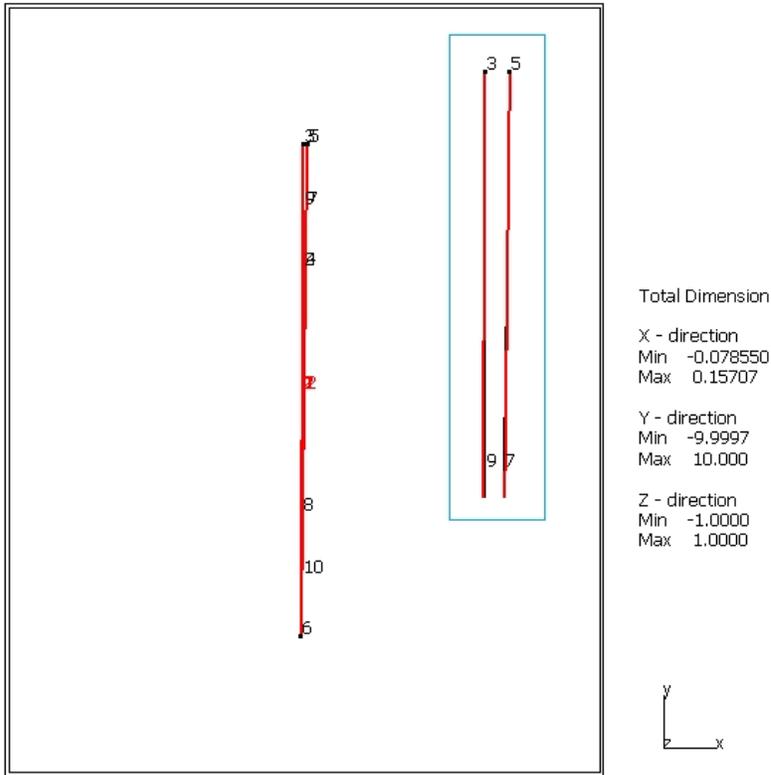
Figure 7.86 Block mesh for Example 5



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX5\EX5.Mes

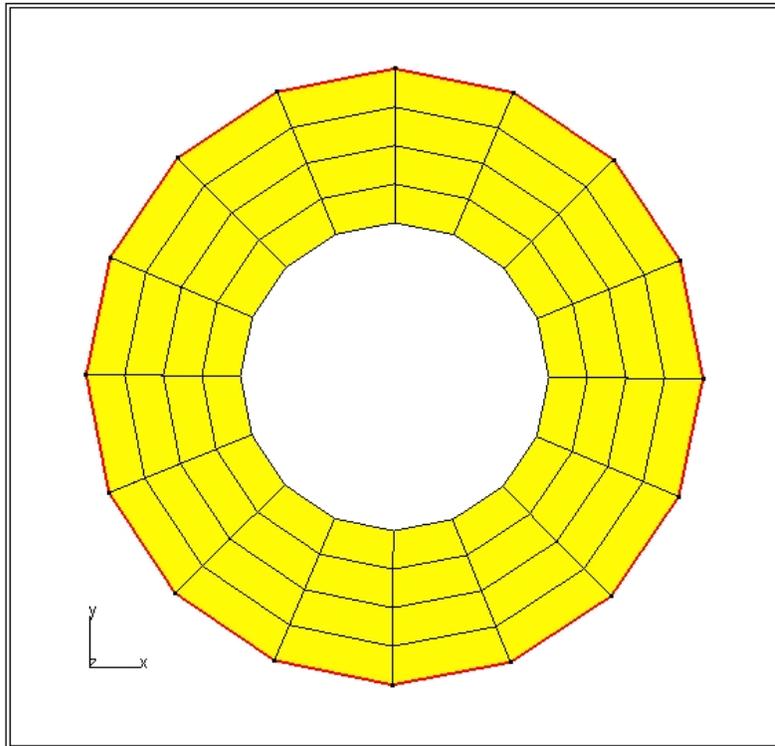
Figure 7.87 Finite element mesh for Example 5

**7.7.6 Example 6: Surface and Line Element (2)**



SURFACE AND LINE ELEMENT GENERATION: EX6.RGN [2D-S-1B]  
 Node and Block Number

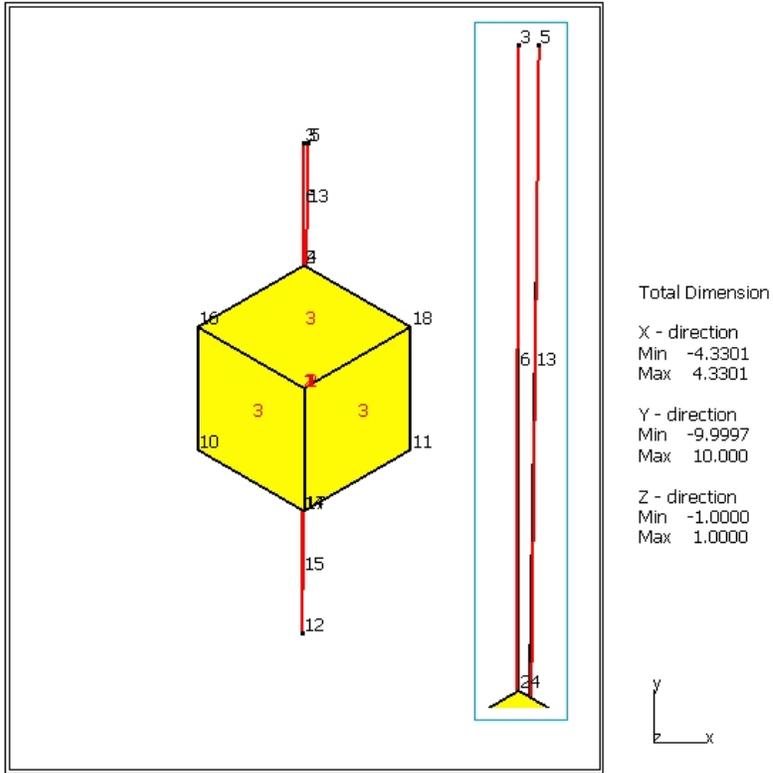
Figure 7.88 Block mesh for Example 6



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX6\EX6.Mes

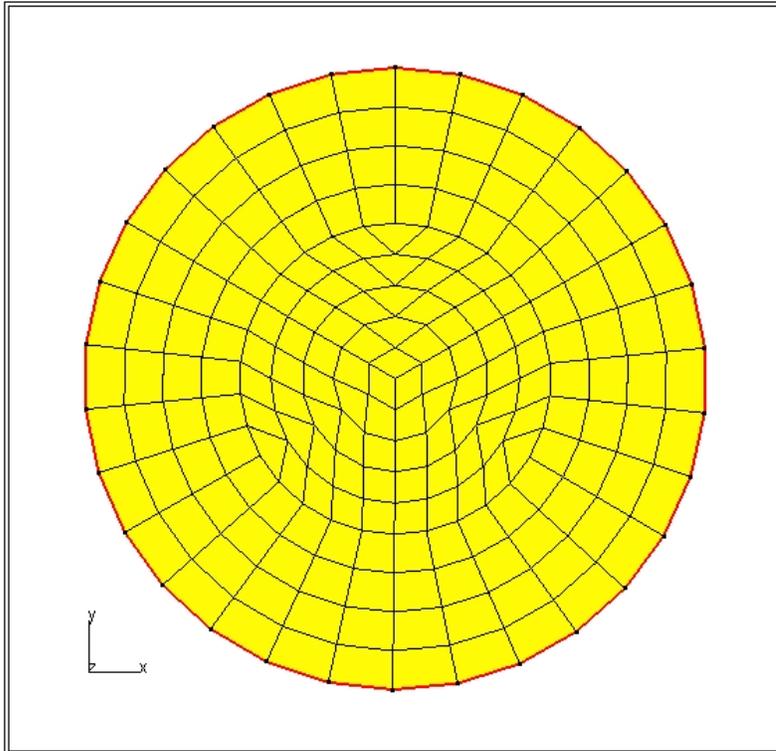
Figure 7.89 Finite element mesh for Example 6

**7.7.7 Example 7: Surface and Line Element (3)**



SURFACE AND LINE ELEMENT GENERATION  
Node and Block Number

Figure 7.90 Block mesh for Example 7



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX7\EX7.Mes

Figure 7.91 Finite element mesh for Example 7

### 7.7.8 Example 8: Cement-Soil Road

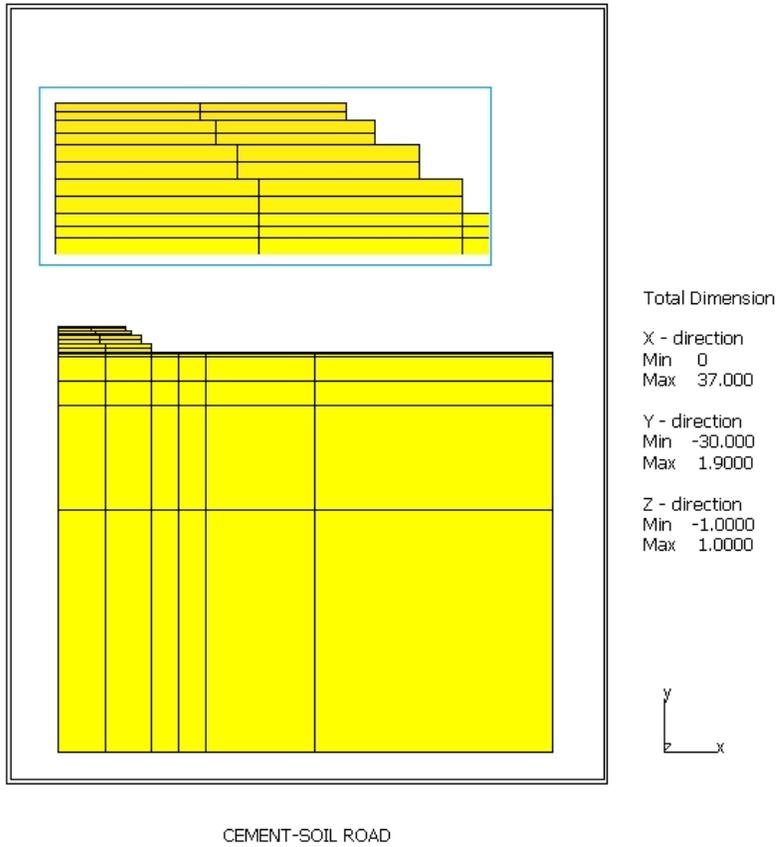
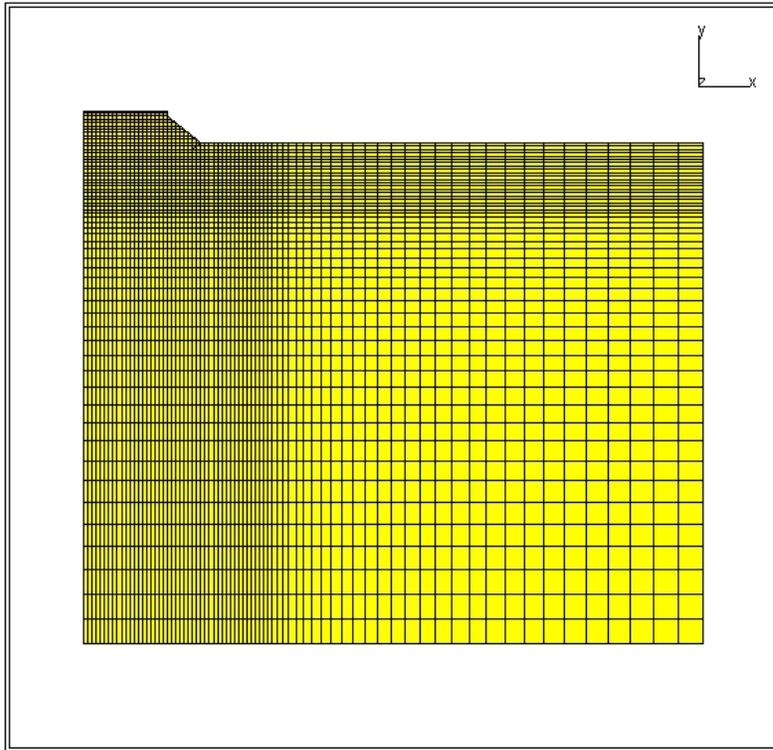


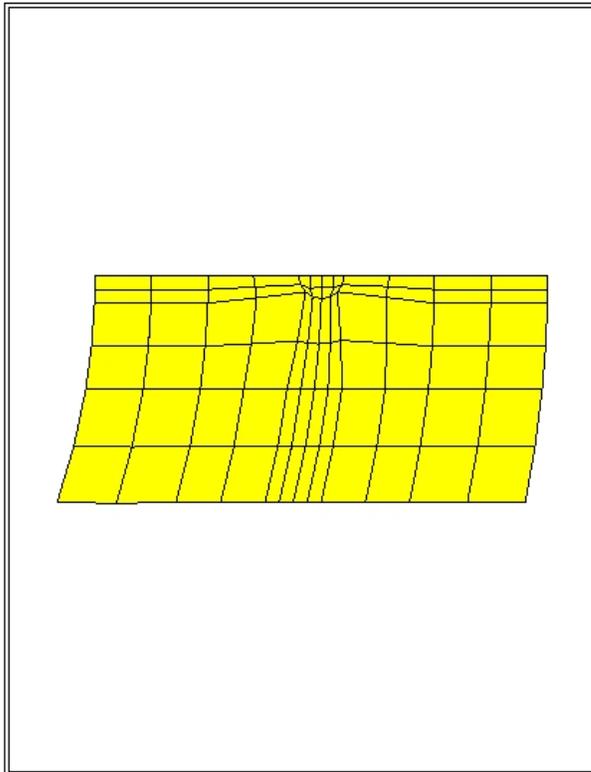
Figure 7.92 Block mesh for Example 8



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX8\EX8.Mes

Figure 7.93 Finite element mesh for Example 8

### 7.7.9 Example 9: Tunnel in Spherical Geometry



Total Dimension

X - direction  
Min 145.66  
Max 254.00

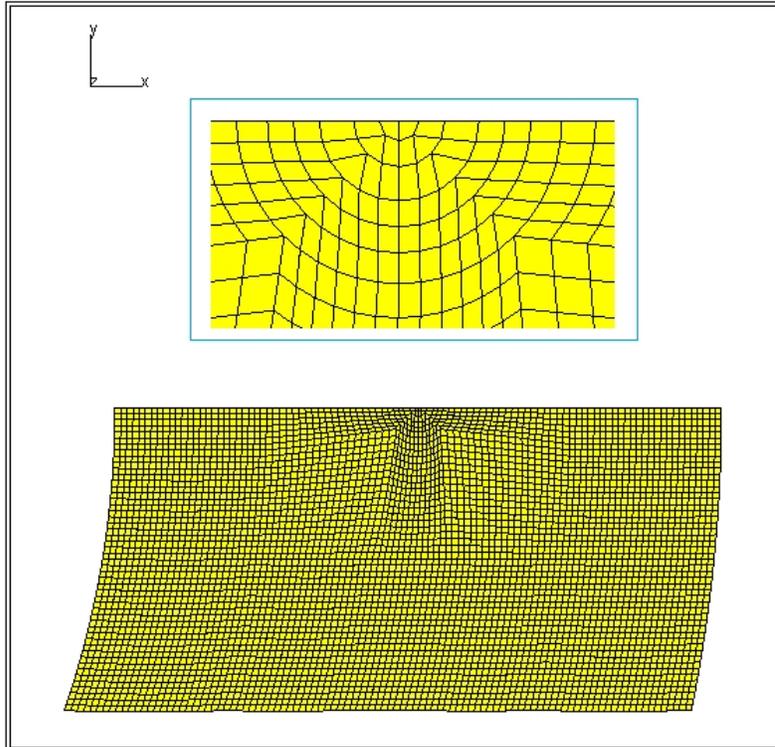
Y - direction  
Min -50.298  
Max 0.014023

Z - direction  
Min -1.0000  
Max 1.0000



Tunnel Subjected To Spherical Wave

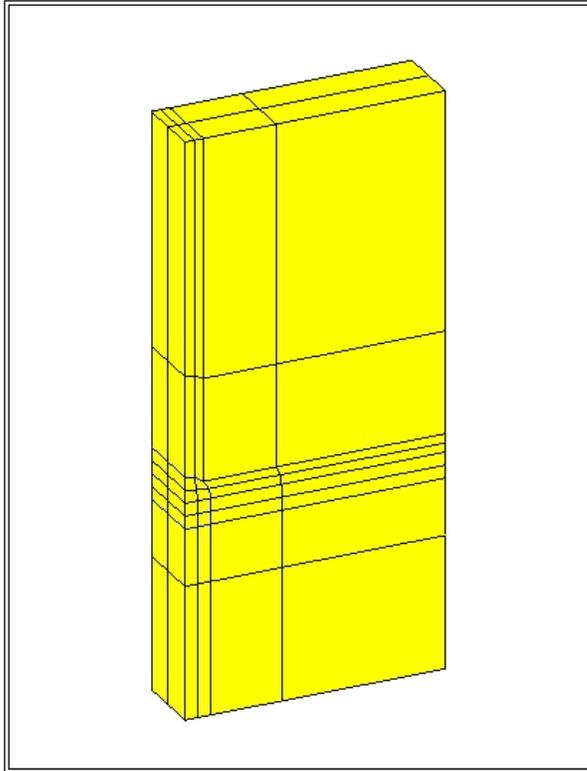
Figure 7.94 Block mesh for Example 9



C:\SMAP\SMART3\EXAMPLE\PRESMAP\PRESM-GP\EX9\EX9.Mes

Figure 7.95 Finite element mesh for Example 9

### 7.7.10 Example 10: Horseshoe Tunnel

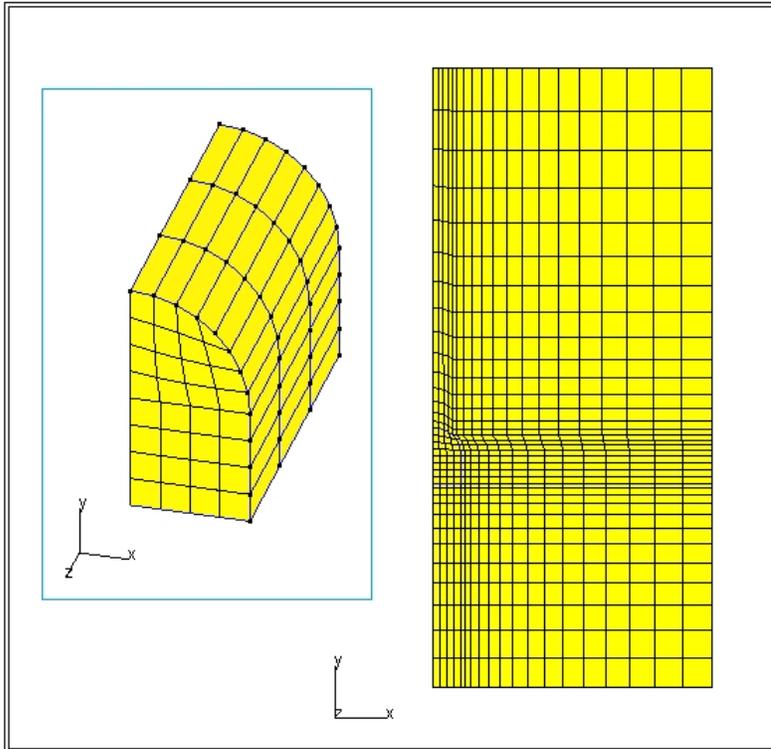


Total Dimension  
X - direction  
Min 0  
Max 360.00  
Y - direction  
Min -300.00  
Max 500.00  
Z - direction  
Min 0  
Max 100.00



Horseshoe Tunnel

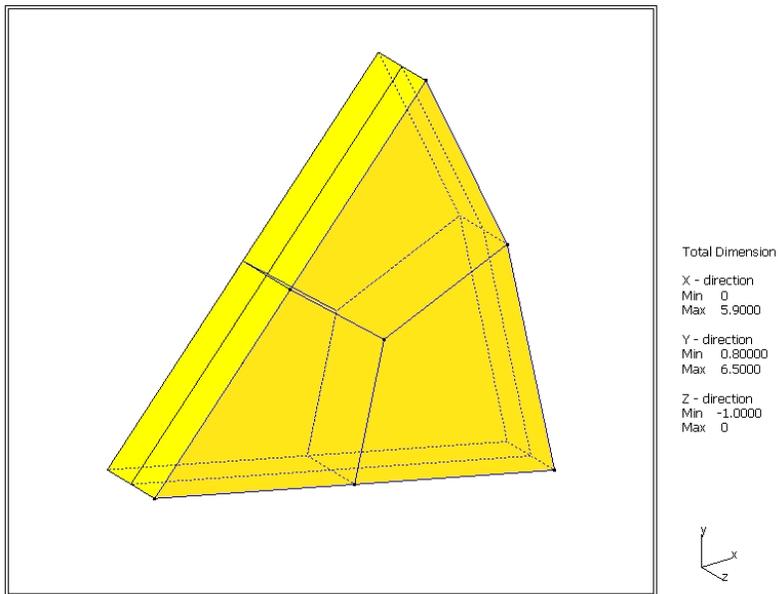
Figure 7.96 Block mesh for Example 10



C:\SMAP\SMAPT3\EXAMPLE\PRESMAP\PRESM-GP\EX10\EX10.Mes

Figure 7.97 Finite element mesh for Example 10

### 7.7.11 Example 11: Wedge Volume and Surface Block



Wedge Volume and Surface Block

Figure 7.98 Block mesh for Example 11

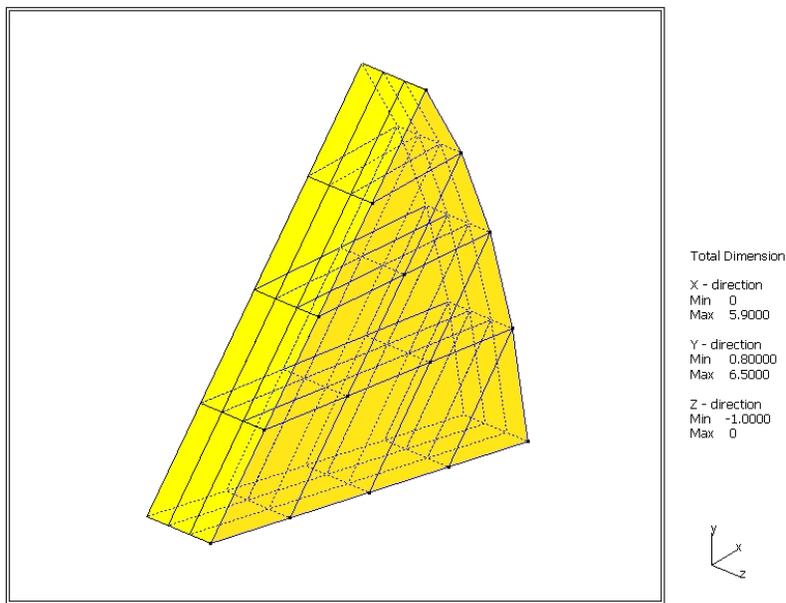


Figure 7.99 Finite element mesh for Example 11

## **ADDRGN Example Problem**

ADDRGN is the pre-processing program which has the following functions:

- Combine two different meshes
- Modify existing meshes
  - Change coordinates
  - Change boundary codes
  - Cut elements
  - Change material numbers
- Generate finite element meshes (ADDRGN-2D)

Refer to SMAP-W3 User's Manual:

- Section 5 for group mesh generation (ADDRGN-2D)
- Section 8 for input parameters

### **8.1 ADDRGN-2D**

ADDRGN-2D is the two dimensional pre-processor which is used to combine, modify, or generate finite element meshes.

ADDRGN-2D can be selected in the following order:

**Run → Mesh Generator → AddRgn → Addrgn 2D**

When you finish the execution of ADDRGN-2D, select **PLOT-3D** to plot modified or generated mesh.

### 8.1.1 Combining Meshes

In the PRESMAP-2D Example Problem in Sections 7.1.1 and 7.1.2, three different regions (Core, Near-field, and Far-field) are generated using Models 1 and 2. Now, we want to combine all these different regions into one using ADDRGN-2D. Note that [CORE.Mes](#), [NEAR.Mes](#) and [FAR.Mes](#) are the output files corresponding to the input file [CORE.Rgn](#), [NEAR.Rgn](#) and [FAR.Rgn](#) respectively.

Element numbers 1 to 72 are assigned for [CORE.Mes](#), 73 to 336 for [NEAR.Mes](#) and 337 to 464 for [FAR.Mes](#). When we combine two regions, element numbers should be continuous through the regions. So, let's first add [NEAR.Mes](#) (called REGION B) to [CORE.Mes](#) (called REGION A) to make [CONE.Mes](#) (called COMBINED REGION). Next, let's add [FAR.Mes](#) (called REGION B) to [CONE.Mes](#) (called REGION A) to make the final mesh [CNF.Mes](#) (called COMBINED REGION). ADDRGN input files are listed in Tables 8.1 and 8.2.

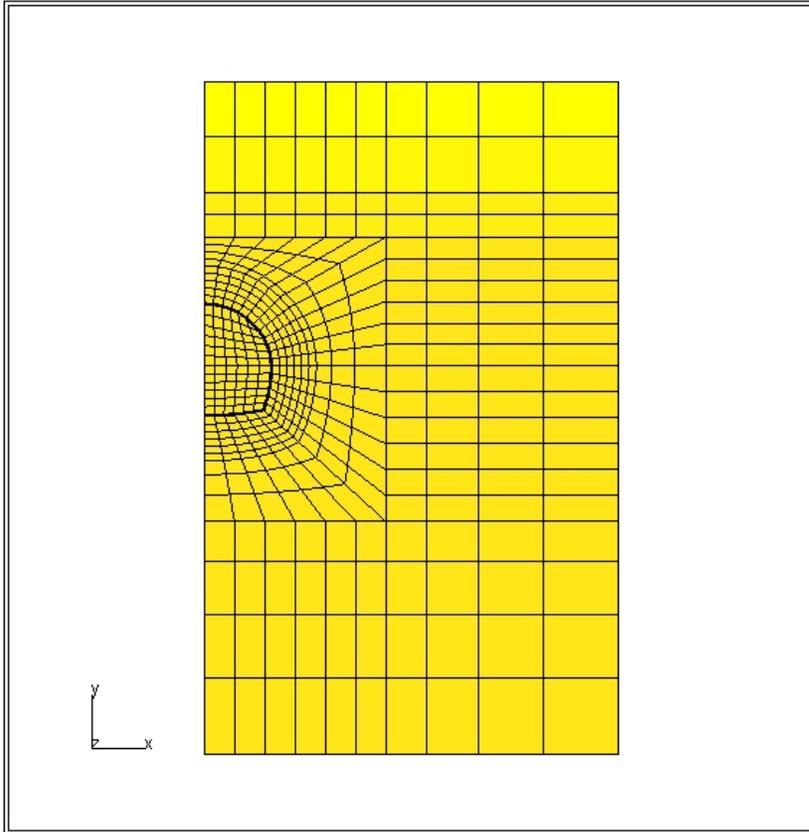
Figure 8.1 shows the element meshes of combined region representing all three regions.

**Table 8.1 Listing of input file ADD2D-1.Dat**

```
* ADD2D-1.Dat
* CARD 1.1
* IMOD = 0 : ADD REGION B TO REGION A
  0
* CARD 2.1
* FILEA : Input file name containing REGION A
  CORE.Mes
* FILEB : Input file name containing REGION B
  NEAR.Mes
* FILEC : Output file name to store COMBINED REGION
  CONE.Mes
* CARD 2.2
* INTERFACE
  0
* END OF DATA
```

**Table 8.2 Listing of input file ADD2D-2.Dat**

```
* ADD2D-2.Dat
* CARD 1.1
* IMOD = 0 : ADD REGION B TO REGION A
  0
* CARD 2.1
* FILEA : Input file name containing REGION A
  CONE.Mes
* FILEB : Input file name containing REGION B
  FAR.Mes
* FILEC : Output file name to store COMBINED REGION
  CNF.Mes
* CARD 2.2
* INTERFACE
  0
* END OF DATA
```



CNF.Mes

Figure 8.1 Final element meshes representing Core, Near-field, and Far-field regions, CNF.Mes

### 8.1.2 Modifying Mesh

In this example, we want to generate symmetric meshes using ADDRGN-2D. As the existing mesh, we take the **CORE.Mes** which has been generated using PRESMAP-2D Model 1 (refer to Section 7.1.1.2). Note that **CORE.Mes** represents the right side of the tunnel core. ADDRGN input file to generate **Left Core** is listed in Table 8.3. The output file **LCORE.Mes** contains **Left Core** whose graphical output is shown in Figure 8.2.

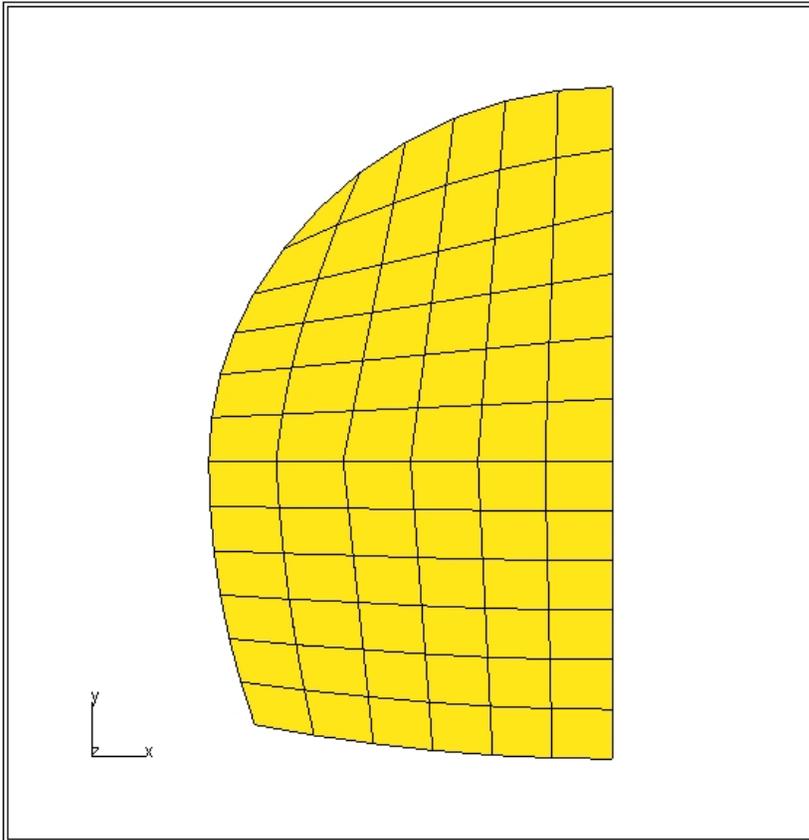
By combining both left and right core regions as instructed in Table 8.4, we can generate a whole core region, **WCORE.Mes**. Graphical output of **WCORE.Mes** is shown in Figure 8.3.

Table 8.3 Listing of input file ADD2D-3.Dat

```
* ADD2D-3.Dat
* CARD 1.1
* IMOD = 1 : MODIFY EXISTING MESH
  1
* CARD 3.1
* FILEA : Input file name to be modified
  CORE.Mes
* FILEM : Output file name to store modified mesh
  LCORE.Mes
* CARD 3.2
* NSNEL  NSNODE
  73     1
* CARD 3.3
* IEDIT = 0 : CHANGE COORDINATES
  0
* CARD 3.3.1.1
* X0      Y0      Xnew    Ynew
  0.0     0.0     0.0     0.0
* CARD 3.3.1.2
* Xscale  Yscale
  -1.0     1.0
* END OF DATA
```

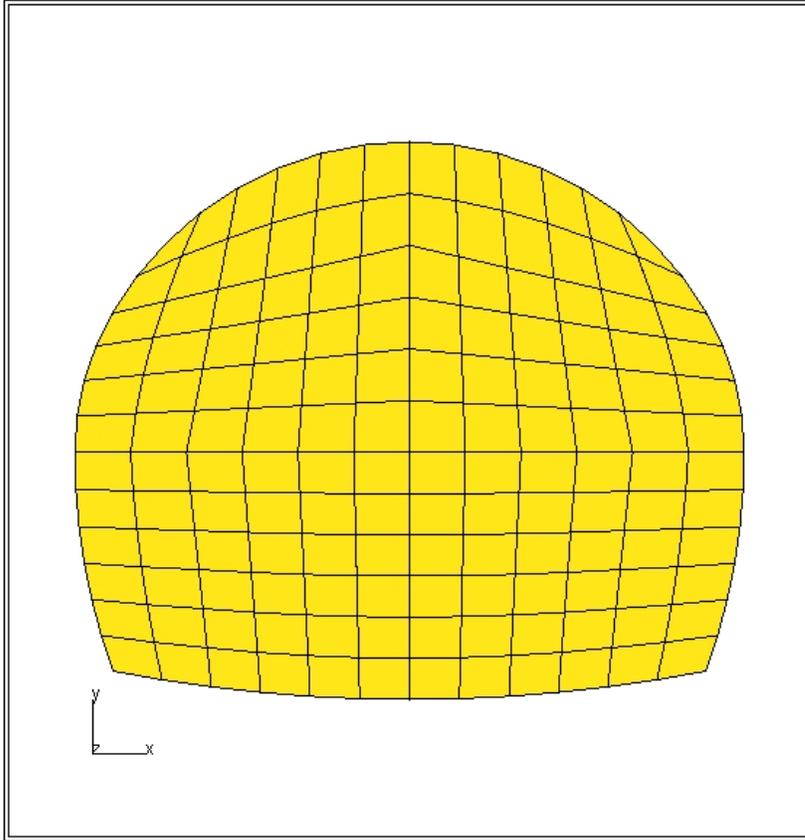
Table 8.4 Listing of input file ADD2D-4.Dat

```
* ADD2D-4.Dat
* CARD 1.1
* IMOD = 0 : ADD REGION B TO REGION A
  0
* CARD 2.1
* FILEA : Input file name containing REGION A
  CORE.Mes
* FILEB : Input file name containing REGION B
  LCORE.Mes
* FILEC : Output file name to store COMBINED REGION
  WCORE.Mes
* CARD 2.2
* INTERFACE
  0
* END OF DATA
```



LCORE.Mes

Figure 8.2 Left core mesh, LCORE.Mes



W Corey.Mes

Figure 8.3 Combined whole core mesh, W Corey.Mes

### 8.1.3 Generating Mesh

This example is to show a powerful mesh generation feature using ADDRGN-2D. All you need to do is to specify the locations, dimensions and material numbers of structures along with few instructions for mesh generation. ADDRGN-2D will do the rest of the work to build the Mesh File.

As the first example, we take a simple problem as schematically shown in Figure 8.4. A utility tunnel with a diameter of 4 meters is located 6 meters below the ground surface. Table 8.5 shows the full listing of input file [ADD2D-5.Dat](#). The base mesh consists of 3 blocks in the horizontal direction and 1 block in the vertical direction.

The first group represents soft rock underlying soil. And the second group represents the utility tunnel. Tunnel liner is modeled by beam element and the interface between the liner and the surrounding soil is modeled by joint element which will allow the slippage and separation. Finite element meshes generated by ADDRGN-2D are shown in Figures 8.5 and 8.6. It should be noted that the joint thickness in Figure 8.6 is exaggerated to show clearly both inner and outer joint faces. The real joint thickness is specified in material property card in Main File.

Table 8.5 Listing of input file ADD2D-5.Dat

```

* ADD2D-5.Dat
* CARD 1.1
* IMOD = 2 : GENERATE BASE MESH AND THEN MODIFY
* IMOD JK
  2  1
* CARD 4.1
* NBX  NBY
  3  1
* CARD 4.2
* XO   YO
  0.0 0.0
* CARD 4.3
* W    DX    ALPAX
  14.0 0.3  -0.3
  21.0 0.3   0.5
  11.0 0.3   0.3
* CARD 4.4
* H    DY    ALPAY
  20.0 0.3   0.5
* CARD 4.5
* IGMOD
  1
* -----
* CARD 3.1
* FILEA
  BMESH.Dat
* FILEM
  ADD2D-5.Mes
* CARD 3.2
* NSNEL NSNODE
  1     1
* CARD 3.3
* IEDIT = 4 : BUILD USER-SPECIFIED CURVES.
  4
* CARD 3.3.5.1
* NODE
  0
* CARD 3.3.5.2
* NOEL
  0
* CARD 3.3.5.3
* IBOUND
  0

```

```

* CARD 3.3.5.4
* NGROUP
  2
* XREF  YREF
  14.0  20.0
* ----- GROUP 1 -----
*
*                               SOFT ROCK
*
* CARD 3.3.5.4.1.1
* MTYPE
  3
* CARD 3.3.5.4.1.2
* MATNO IDH  LTPI  LMAT
  7   0   0   0
* CARD 3.3.5.4.2.1
* NPOINT MOVE  IREF  XLO  YLO
  6   1   0   0.0  0.0
* CARD 3.3.5.4.2.2
* NP   X   Y
  1  0.0  0.0
  2 46.0  0.0
  3 46.0 13.0
  4 31.0 12.0
  5 19.0  8.0
  6  0.0  4.0
* CARD 3.3.5.4.3
* NSEGMENT
  6
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  1     1     0     3
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  2     1     0     3
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  3     1     0     2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  4     1     0     2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  5     1     0     2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  6     1     0     2

```

## 8-12 ADDRGN-2D Example Problem

---

```
* ----- GROUP 2 -----  
*           UTILITY TUNNEL  
* CARD 3.3.5.4.1.1  
* MTYPE  
*   -3  
* CARD 3.3.5.4.1.2  
* MATNO IDH MATNOJT IDHJT THICJT LTPI, LMATI, LTPO, LMATO  
*   3   0   4       0   0.1   2   5   2   6  
* CARD 3.3.5.4.2.1  
* NPOINT MOVE IREF XLO YLO  
*   1     0   1   8.0 -6.0  
* CARD 3.3.5.4.2.2  
* NP X Y  
*   1 2.0 0.0  
* CARD 3.3.5.4.3  
* NSEGMENT  
*   1  
* CARD 3.3.5.4.3.1  
* SEGNO LTYPE NDIV IEND  
*   1     2     0   2  
* CARD 3.3.5.4.3.2  
* X0 Y0 RX RY THETA_B THETA_E  
* 0.0 0.0 2.0 2.0 0.0 360.  
* -----  
* END OF DATA
```

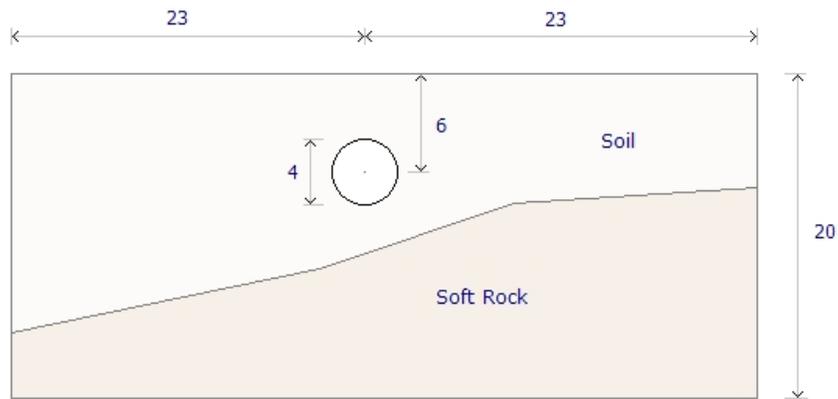
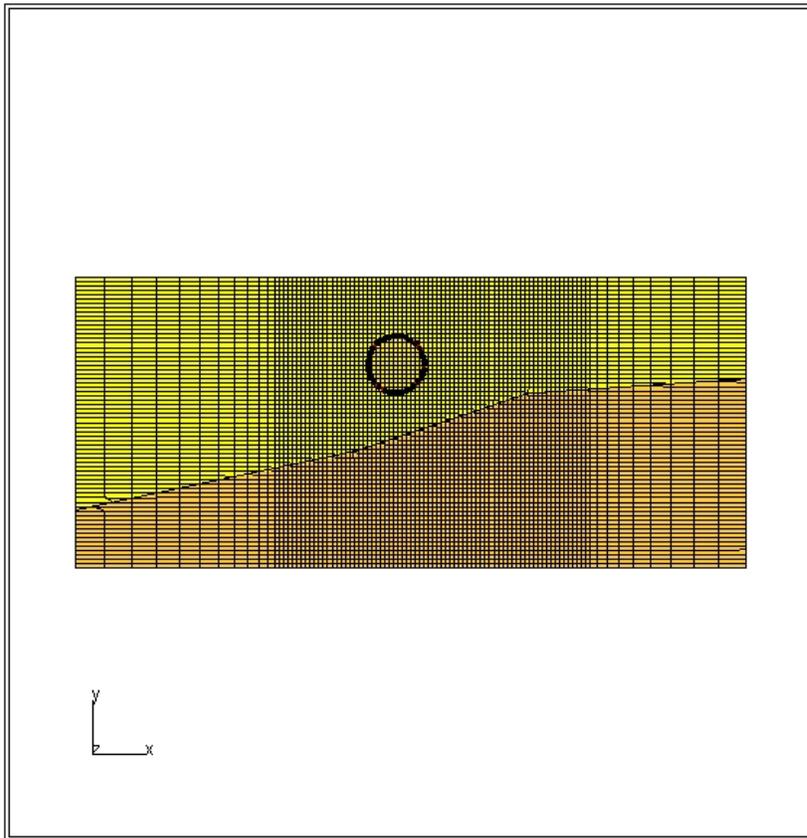
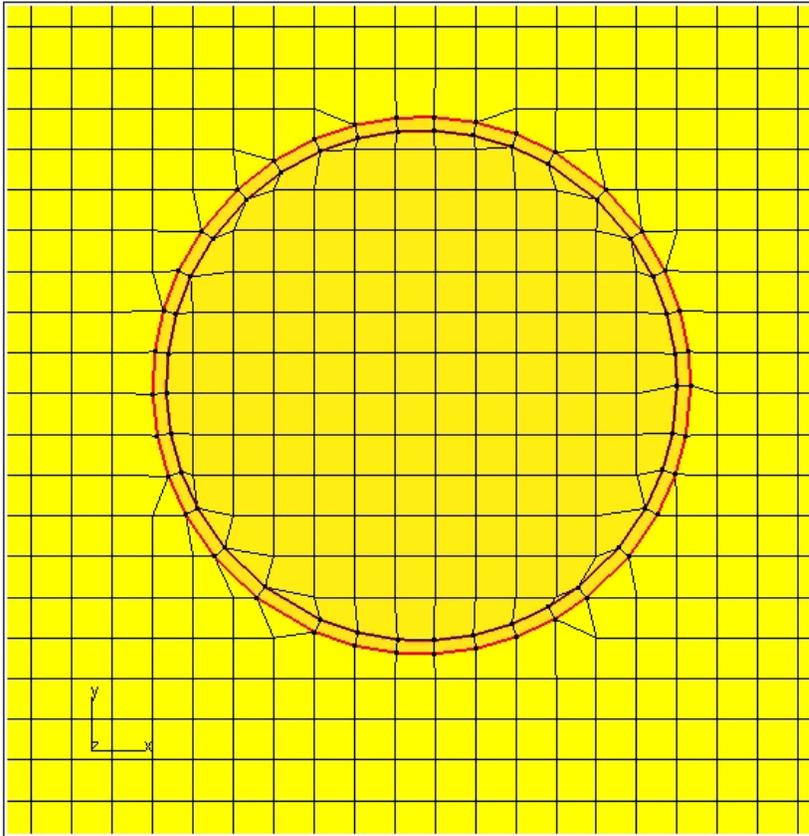


Figure 8.4 Schematic section view.



ADD2D-5.Mes

Figure 8.5 Overall finite element mesh



ADD2D-5.Mes

Figure 8.6 Finite element mesh around utility tunnel.

As the second example, we take a complex problem as schematically shown in Figure 8.7. The problem geometry includes different types of underground structures; strut, anchor bar, pile, utility tunnel, subway tunnel, rock bolt, foundation and fault zone. Table 8.6 shows the partial listing of input file `ADD2D-6.Dat`. The base mesh consists of 3 blocks in the horizontal direction and 2 blocks in the vertical direction.

For detailed description of input parameters, refer to Section 8.2 in SMAP-3D User's Manual. Joint elements are used to model the fault zone and the interfaces between surrounding medium and the structures such as pile and tunnels. Figure 8.8 shows overall finite element mesh generated by ADDRGN-2D. Detailed finite element meshes are shown in Figure 8.9 for the excavation zone and in Figure 8.10 for the tunnels and foundation. As in the previous example, the joint thickness in Figures 8.9 and 8.10 is exaggerated to show clearly both inner and outer joint faces. The real joint thickness is specified in material property card in Main File.

**Table 8.6** Listing of input file `ADD2D-6.Dat` (Partial Listing)

```
* ADD2D-6.Dat
* CARD 1.1
* IMOD = 2 : GENERATE BASE MESH AND THEN MODIFY
* IMOD JK
  2   1
* CARD 4.1
* NBX  NBY
  3   2
* CARD 4.2
* XO   YO
  0.0  0.0
* CARD 4.3
* W    DX    ALPAX
  14.0 0.3  -0.3
  21.0 0.3   0.5
  11.0 0.3   0.3
* CARD 4.4
* H    DY    ALPAY
  23.0 0.3   0.5
  16.0 0.3   0.3
```

```

* CARD 4.5
* IGMOD
  1
* -----
* CARD 3.1
* FILEA
  BMESH.Dat
* FILEM
  ADD2D-6.Mes
* CARD 3.2
* NSNEL  NSNODE
  1      1
* CARD 3.3
* IEDIT = 4 : BUILD USER-SPECIFIED CURVES.
  4
* CARD 3.3.5.1
* NODE
  0
* CARD 3.3.5.2
* NOEL
  0
* CARD 3.3.5.3
* IBOUND
  0
* CARD 3.3.5.4
* NGROUP
  22
* XREF  YREF
  14.0  39.0
* ----- GROUP 1 -----
*
*           MAKING GROUND SURFACE
*
* CARD 3.3.5.4.1.1
* MTYPE
  -1
* CARD 3.3.5.4.2.1
* NPOINT  MOVE  IREF  XLO  YLO
  8      1      0      0.0  0.0
* CARD 3.3.5.4.2.2
* NP    X      Y
  1  46.0  34.0
  2  39.0  34.0
  3  33.0  39.0
  4  18.0  39.0
  5  12.0  34.0
  6   0.0  34.0
  7   0.0   0.0
  8  46.0   0.0

```

## 8-18 ADDRGN-2D Example Problem

```
* CARD 3.3.5.4.3
* NSEGMENT
  8
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  1      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEDN
  2      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  3      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEDN
  4      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  5      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEDN
  6      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  7      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEDN
  8      1      0      2
* ----- GROUP 2 -----
*
*                               SOFT ROCK
*
* CARD 3.3.5.4.1.1
* MTYPE
  3
* CARD 3.3.5.4.1.2
* MATNO  IDH  LTPI  LMAT
  7      0      0      0
* CARD 3.3.5.4.2.1
* NPOINT  MOVE  IREF  XLO  YLO
  6      1      0      0.0  0.0
* CARD 3.3.5.4.2.2
* NP      X      Y
  1  46.0  0.0
  2  46.0  33.0
  3  31.0  32.0
  4  19.0  28.0
  5   0.0  24.0
  6   0.0   0.0
```

```

* CARD 3.3.5.4.3
* NSEGMENT
  6
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  1      1      0      3
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  2      1      0      3
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  3      1      0      0
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  4      1      0      0
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  5      1      0      0
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  6      1      0      3
* ----- GROUP 3 -----
*
*                               FAULT
*
* MTYPE
  -2
* CARD 3.3.5.4.1.2
* MATNOJT IDHJT THICJT  LTPI, LMATI, LTPO, LMATO
  5      0      -0.1      0      0      0      0
* CARD 3.3.5.4.2.1
* NPOINT  MOVE  IREF  XLO  YLO
  4      1      0      0.0  0.0
* CARD 3.3.5.4.2.2
* NP  X      Y
  1  46.0  29.0
  2  29.0  19.0
  3  16.0  14.0
  4   0.0  10.0
* CARD 3.3.5.4.3
* NSEGMENT
  3
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
  1      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEDN
  2      1      0      2

```

## 8-20 ADDRGN-2D Example Problem

```
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      3      1      0      2
* ----- GROUP 4 -----
*
*                          FOUNDATION
*
* CARD 3.3.5.4.1.1
* MTYPE
      4
* CARD 3.3.5.4.1.2
* MATNO  IDH  LTPI  LMAT
      2      0      0      0
* CARD 3.3.5.4.2.1
* NPOINT  MOVE  IREF  XLO  YLO
      8      1      0    0.0  0.0
* CARD 3.3.5.4.2.2
* NP   X      Y
      1  34.5  29.0
      2  34.5  30.0
      3  32.5  30.5
      4  32.5  39.0
      5  31.5  39.0
      6  31.5  30.5
      7  29.5  30.0
      8  29.5  29.0
* CARD 3.3.5.4.3
* NSEGMENT
      8
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      1      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      2      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      3      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      4      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      5      1      0      2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
      6      1      0      2
* CARD 3.3.5.4.3.1
```

```

* SEGNO  LTYPE  NDIV  IEND
   7      1     0     2
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
   8      1     0     2
* ----- GROUP 5 -----
*
*                LEFT UTILITY TUNNEL
*
* CARD 3.3.5.4.1.1
* MTYPE
  -3
* CARD 3.3.5.4.1.2
* MATNO IDH MATNOJT IDHJT THICJT  LTPI, LMATI, LTPO, LMATO
   3   0   4       0   -0.1    2    5    2    6
* CARD 3.3.5.4.2.1
* NPOINT MOVE  IREF  XLO  YLO
   1     0   1    8.0  -6.0
* CARD 3.3.5.4.2.2
* NP  X    Y
   1  2.0  0.0
* CARD 3.3.5.4.3
* NSEGMENT
   1
* CARD 3.3.5.4.3.1
* SEGNO  LTYPE  NDIV  IEND
   1      2     0     2
* CARD 3.3.5.4.3.2
* X0   Y0   RX   RY   THETA_B  THETA_E
  0.0  0.0  2.0  2.0  0.0      360.
* ----- GROUP 6 -----
*
*                RIGHT UTILITY TUNNEL
*
* CARD 3.3.5.4.1.1
* MTYPE
  -3
* CARD 3.3.5.4.1.2
* MATNO KF MATNOJT KFJT  THICJT  LTPI, LMATI, LTPO, LMATO
   3   0   4       0   -0.1    2    5    2    6
* CARD 3.3.5.4.2.1

```

---

---

## 8-22 ADDRGN-2D Example Problem

```
* ----- GROUP 22 -----  
*  
*                SUBWAY TUNNEL  
*  
* CARD 3.3.5.4.1.1  
* MTYPE IGPOST OVERLAY GCOLOR GLTYPE GLTHIC GHIDE  
  -3   0   0   0   0   0   0  
* Card 3.3.5.4.1-1  
* MAT IDH MATj IDHj THICj  LTi LMi LTo LMo  
   3   0   4   0  -0.100   2   5   2   6  
* CARD 3.3.5.4.2.1  
* NPOINT MOVE  IREF  XLO  YLO  
   4   1   1   0.0  0.0  
* CARD 3.3.5.4.2.2  
* NP  X    Y  
   1  26.  24.  
   2  20.  24.  
   3  20.  20.  
   4  26.  20  
* CARD 3.3.5.4.3  
* NSEGMENT  
   4  
* CARD 3.3.5.4.3.1  
* SEGNO LTYPE  NDIV  IEND  
   1     2     0     2  
* Card 3.3.5.4.3.1-1  
* Xo    Yo    Rx    Ry    Qb    Qe  
  23.  24.   3.0  3.0  0.0  180.  
* Card 3.3.5.4.3.1  
* SEGNO LTYPE  NDIV  IEND  
   2     1     0     2  
* Card 3.3.5.4.3.1  
* SEGNO LTYPE  NDIV  IEND  
   3     1     0     2  
* Card 3.3.5.4.3.1  
* SEGNO LTYPE  NDIV  IEND  
   4     1     0     2  
* -----  
* END OF DATA
```

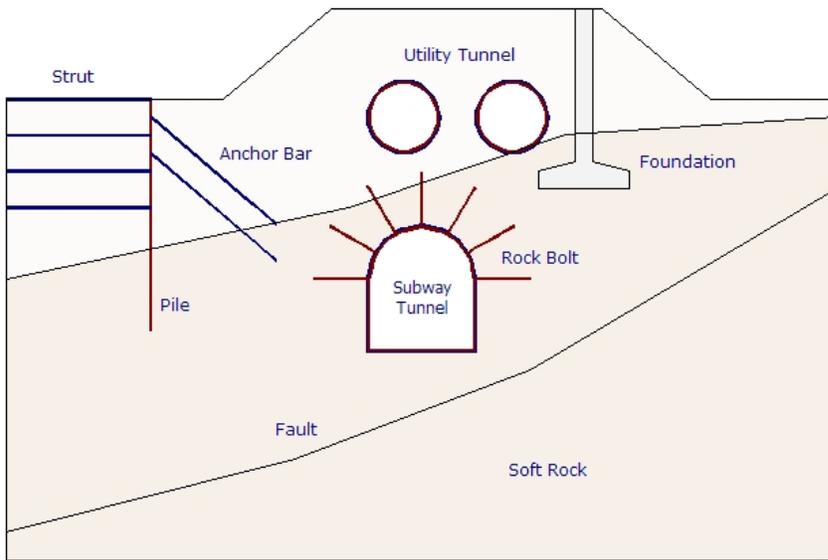
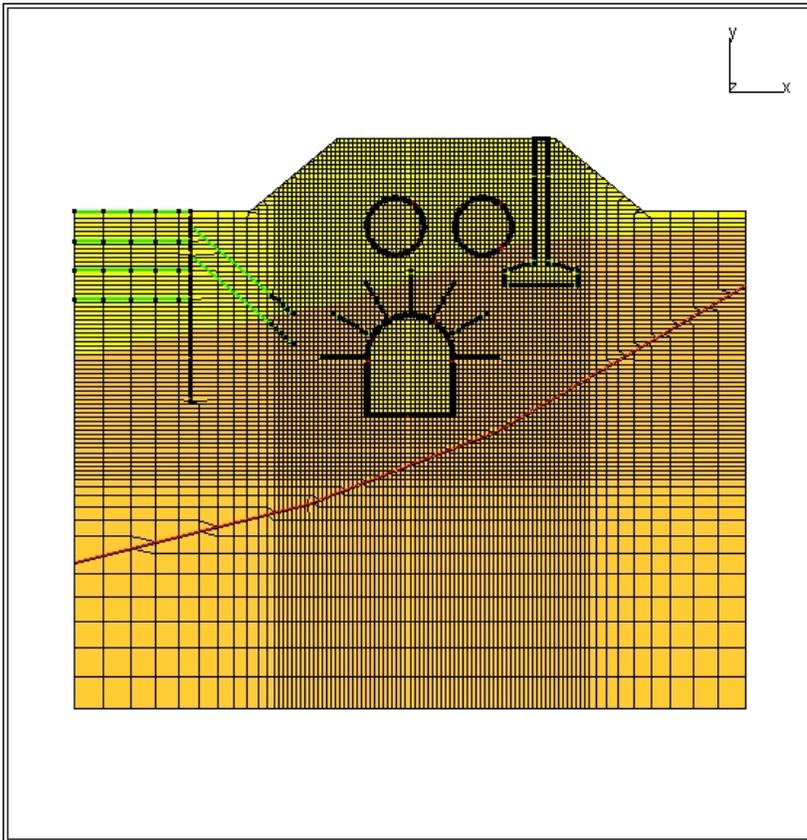
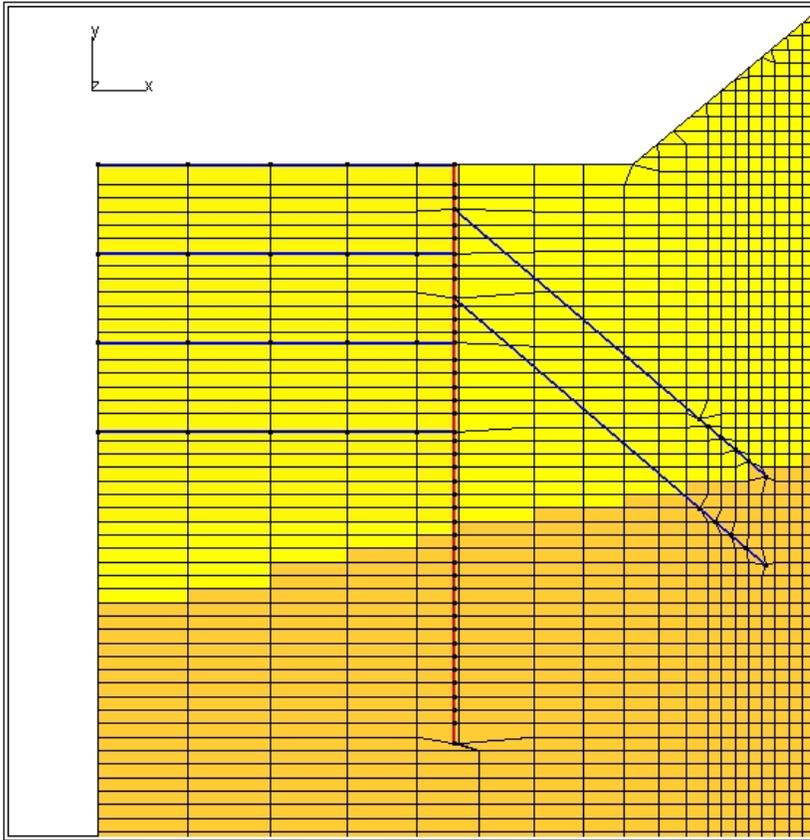


Figure 8.7 Schematic section view



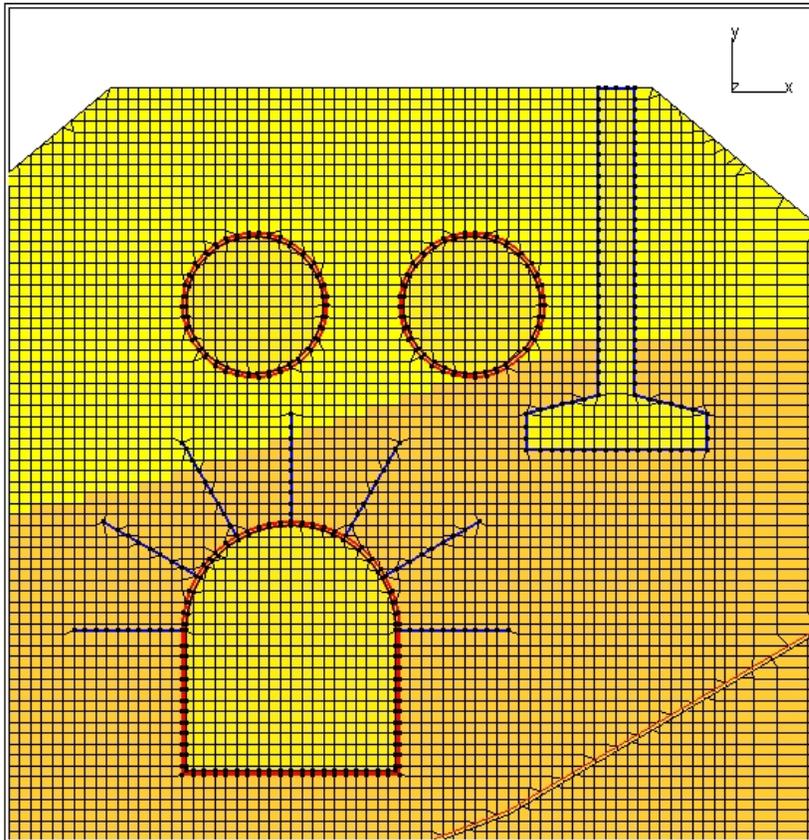
ADD2D-6.Mes

Figure 8.8 Overall finite element mesh



ADD2D-6.Mes

Figure 8.9 Finite element mesh around excavation zone



ADD2D-6.Mes

Figure 8.10 Finite element mesh around tunnels and foundation

## 8.2 ADDRGN-3D

ADDRGN-3D is mainly used to combine or modify the existing three dimensional continuum meshes.

ADDRGN-3D can be selected in the following order:

Run → Mesh Generator → AddRgn → Addrgn 3D

When you finish the execution of ADDRGN-3D, select **PLOT-3D** to plot the combined or modified mesh.

### 8.2.1 Combining Meshes

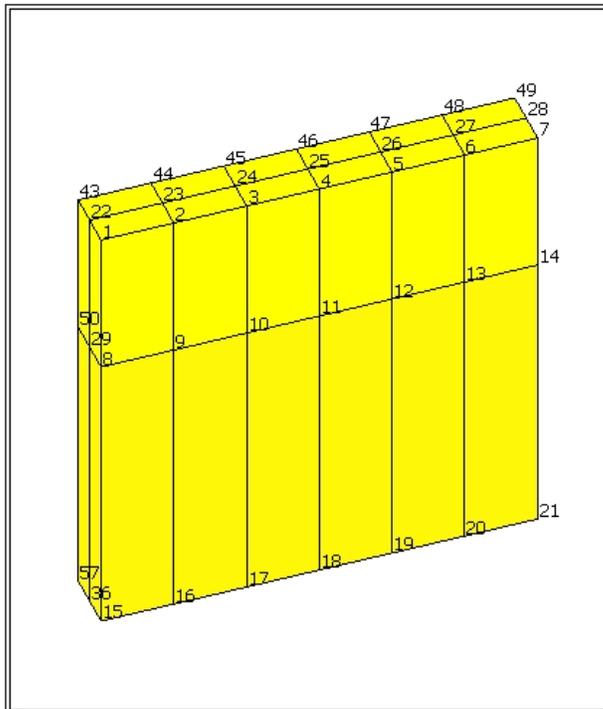
In this example, ADDRGN-3D is used to combine two different regions; FARA3D and FARB3D. FARA3D has 63 nodes and 24 elements as shown in Figure 8.11. FARB3D has 84 nodes and 36 elements as shown in Figure 8.12.

Both FARA3D and FARB3D have the common plane at  $y=10$  where both regions share the identical nodal coordinates. Element numbers 1 to 24 are assigned for FARA3D and 25 to 60 for FARB3D. Note that element numbers should be continuous when combining two regions. The output file, **FAR3D.Mes**, is obtained by adding **FARB3D.Mes** (called REGION B) to **FARA3D.Mes** (called REGION A) as specified in input file **ADD3D-1.Dat** in Table 8.7. Graphical output for the combined region FAR3D is presented in Figure 8.13.

This example also demonstrates that ADDRGN-3D combines not only meshes but also nodal damping constants for transmitting boundary. Combined nodal damping constants are listed at the end of element indexes in the output file **FAR3D.Mes**.

**Table 8.7** Listing of input file ADD3D-1.Dat

```
* ADD3D-1.Dat
* CARD 1.1
* IMOD = 0 : ADD REGION B TO REGION A
  0
* CARD 2.1
* FILEA : Input file name containing REGION A
  FARA3D.Mes
* FILEB : Input file name containing REGION B
  FARB3D.Mes
* FILEC : Output file name to store COMBINED REGION
  FAR3D.Mes
* END OF DATA
```



Total Dimension

X - direction  
 Min 0  
 Max 14.000

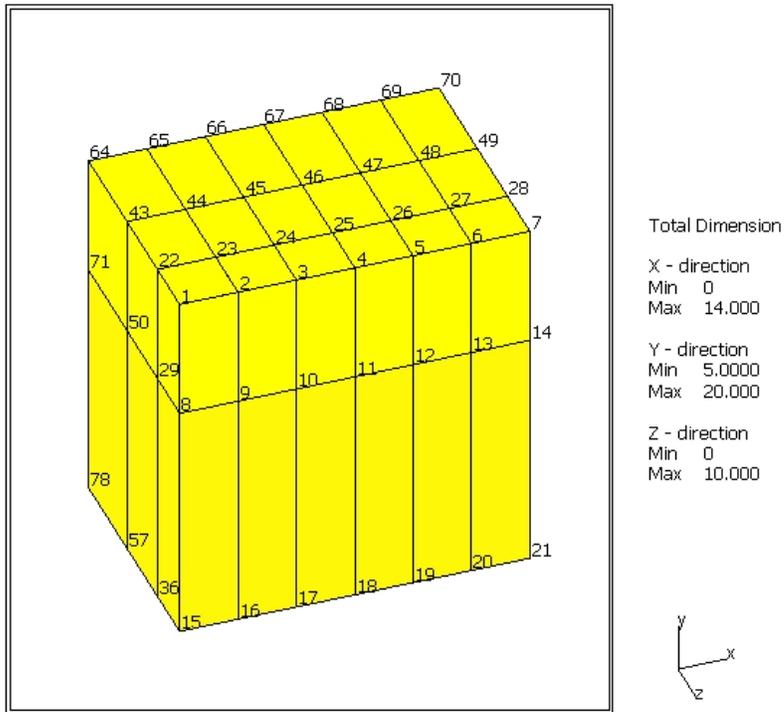
Y - direction  
 Min 5.0000  
 Max 20.000

Z - direction  
 Min 10.000  
 Max 12.000



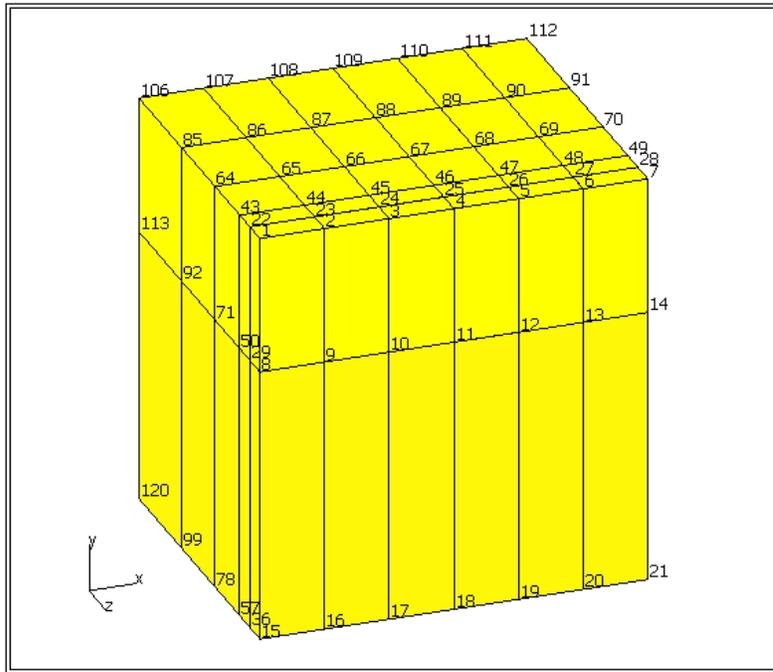
3D Section : FARA3D.Mes  
 Node Number

Figure 8.11 Node numbers for FARA3D.Mes



3D Section : FARB3D.Mes  
Node Number

Figure 8.12 Node numbers for FARB3D.Mes



FAR3D.Mes  
Node Number

Figure 8.13 Node numbers for generated output FAR3D.Mes

### **8.2.2 Modifying Mesh**

In this example, we want to generate symmetric meshes using ADDRGN-3D. As the existing mesh, we take the CROSS-3D Model 1 example problem, but generates only top half by specifying IPART=1 in card Group 2.1.2. Table 8.8 shows the listing of CROSS-3D input file [CRM1-TOP.Dat](#). Graphical output is shown in Figure 8.14.

To generate bottom half which is symmetric about the plane at  $y=0$ , you can execute the input file [ADD3D-2.Dat](#) in Table 8.9. Graphical output is shown in Figure 8.15.

By combining both top and bottom regions, we can generate a whole region [WCRM1.Mes](#). Input file [ADD3D-3.Dat](#) in Table 8.10 is used to build the combined mesh. Graphical output of this combined region is shown in Figure 8.16.

**Table 8.8** Listing of CROSS-3D input file CRM1-TOP.Dat

```

* CARD 1.1
* TITLE
  Identical two crossing tunnels (MODELNO = 1)
* CARD 1.2
* MODELNO IDH NSNODE  NSNEL  CMFAC
   1      1    1      1     1.0
* CARD 2.1.1
* XL      YB      YT      ZL      t
 100.    50.    100.   100.   3.0
* CARD 2.1.2
* IPART  NDR  NTBND  NTOPN
   1     2    20     20
* CARD 2.1.3
* NTNODE
  9
* NODE  X      Y
   1   0.0    4.0
   2  2.8284  2.8284
   3   4.0    0.0
   4   4.0   -2.0
   5   0.0   -3.0
   6  1.53    3.7
   7   3.7    1.53
   8   4.0   -1.0
   9   2.0   -2.7
* CARD 3.1
* NBOUND
  6
* CARD 3.2
* IBTYPE ISX  ISY  ISZ  IFX  IFY  IFZ
   1     0   0   0   1   1   1
   2     0   0   1   1   1   1
   3     0   0   1   1   1   1
   4     1   0   0   1   1   1
   5     1   0   0   1   1   1
   7     0   1   0   1   1   1
* END OF DATA

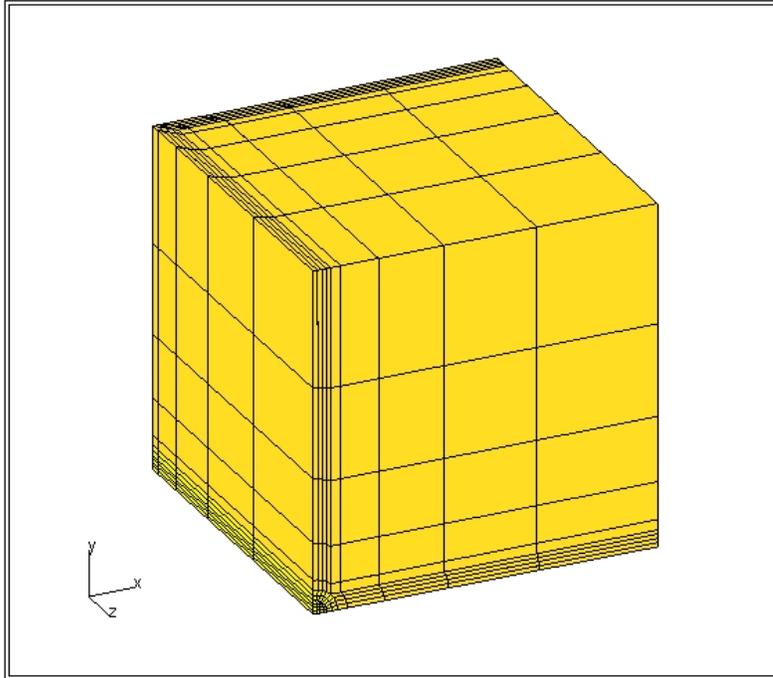
```

**Table 8.9** Listing of input file ADD3D-2.Dat

```
* ADD3D-2.Dat
* CARD 1.1
* IMOD = 1 : MODIFY EXISTING MESH
  1
* CARD 3.1
* FILEA : Input file name to be modified
  CRM1-TOP.Mes
* FILEM : Output file name to store modified mesh
  CRM1-BOT.Mes
* CARD 3.2
* NSNEL  NSNODE
  746    1
* CARD 3.3
* IEDIT = 0 : CHANGE COORDINATES
  0
* CARD 3.3.1.1
* Xo     Yo     Zo       Xonew  Yonew  Zonew
  0.0    0.0    0.0      0.0    0.0    0.0
* CARD 3.3.1.2
* Xscale Yscale Zscale
  1.0    -1.0    1.0
* END OF DATA
```

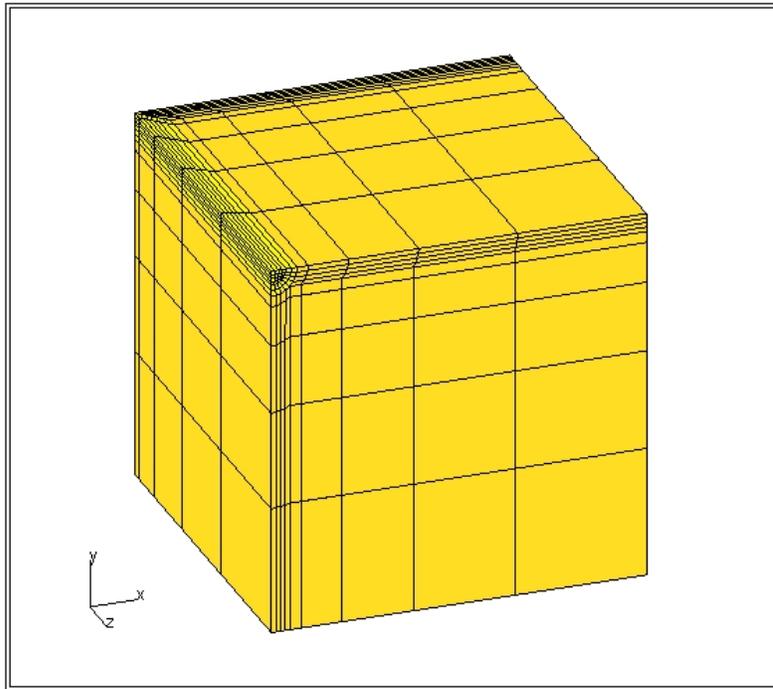
**Table 8.10** Listing of input file ADD3D-3.Dat

```
* ADD3D-3.Dat
* CARD 1.1
* IMOD = 0 : ADD REGION B TO REGION A
  0
* CARD 2.1
* FILEA : Input file name containing REGION A
  CRM1-TOP.Mes
* FILEB : Input file name containing REGION B
  CRM1-BOT.Mes
* FILEC : Output file name to store COMBINED REGION
  WCRM1.Mes
* END OF DATA
```



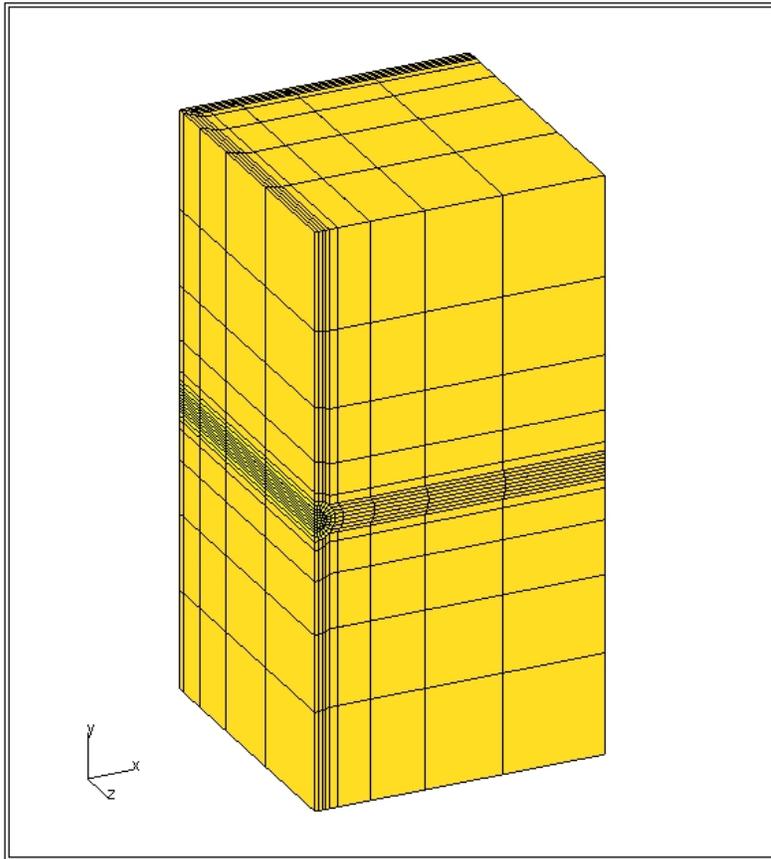
FILE NAME : CRM1-TOP.Mes

Figure 8.14 Finite element mesh for top half region



CRM1-BOT.Mes

Figure 8.15 Finite element mesh for bottom half region



WCRM1.Mes

Figure 8.16 Finite element mesh for combined region

## SUPPLEMENT Example Problem

SUPPLEMENT Menu contains supporting programs which are useful to prepare input data for pre- and main-processing programs of SMAP-W3.

Running SUPPLEMENT is described in Section 3.2.6 of User's Manual and can be selected in the following order:

Run → Mesh Generater → Supplement → Edit, XY. Cards or Shrink File

EDIT is used to run text editor.

XY computes coordinates of mid points, cross points, or normal points.

CARDS generates element activity data in Card 8 in Section 4.4 Main File.

SHRINK FILE removes extra blank spaces before carriage return. This will reduce the size of the file.

### 9.1 XY Example Problem

XY is the supporting program which computes coordinates of mid points, cross points, or normal points. Full description of XY is presented in Section 9.3 of User's Manual.

As an example, we select **NF=6** which computes coordinates of point normal to the circular arc as shown in Figure 9.1.

Table 9.1 illustrates options available to the program XY and the user inputs specific to NF=6. Computed coordinates of the normal point are stored in the output file **XY.Out** and are listed in bottom part of Table 9.1.

Table 9.1 XY Example Problem

Type file name to store output: **XY.Out**

- NF = 0 End of Computation
- 1 Compute Midpoint on Straight Line
- 2 Compute Midpoint on circular Arc
- 3 Compute Intersection Point of Two Straight Lines
- 4 Compute Intersection Point of Circular Arc and Straight Line
- 5 Compute Points Normal to Straight Line
- 6 Compute Points Normal to Circular Arc

NF= **6**

R, X<sub>o</sub>, Y<sub>o</sub>, TA  
**5.0 0.0 0.0 0.0**

TAC, CD  
**45.0 3.0**

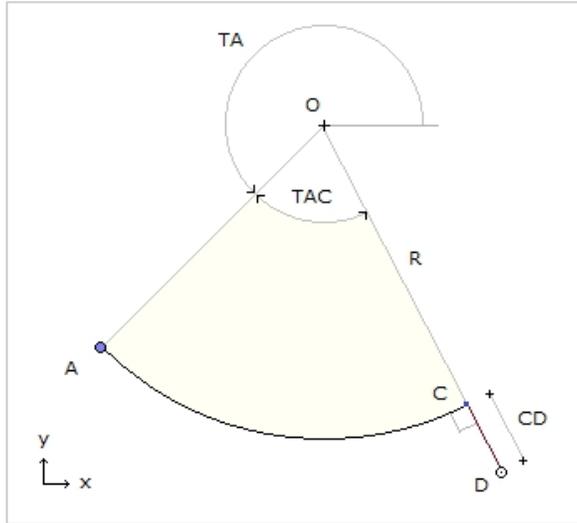
User inputs are **bold**.

Output file contains following information:

**Compute Points Normal to Circular Arc**

R = 5.  
X<sub>o</sub> = 0. Y<sub>o</sub> = 0.  
TA = 0.  
TAC = 45. CD = 3.  
XC = 3.535527 YC = 3.535540  
XD = 5.656844 YD = 5.656865

NF = 6 Compute Points Normal to Circular Arc



INPUT:

$R,$   $X_o,$   $Y_o,$   $TA$   
 $TAC,$   $CD$

$R$  = 5.0  
 $X_o, Y_o$  = 0.0, 0.0  
 $TA$  = 0.0  
 $TAC$  = 45.0  
 $CD$  = 3.0

Figure 9.1 XY example problem

## 9.2 CARDS Example Problem

CARDS is the supporting program which is written to aid the preparation of SMAP-3D input cards. Currently, there is only one routine available to generate element activity data in Card Group 8.2 of Users Manual.

Table 9.2 shows user inputs for the example problem. Generated element activity data is stored in the output file, **CARDS.Out**, which is listed in Table 9.3.

Table 9.2 User inputs for CARDS example problem

CARD NO = 0	Exit
8.2	Element Activity

CARD NO = **8.2**

Type file name to store output: **CARDS.OUT**

NF = 0	End of Generation
1	Generate Element Activity / Deactivity

NF = **1**

NEL (start), NEL (end), NAC, NDAC

**101 120 0 6**

NF = 0	End of Generation
1	Generate Element Activity / Deactivity

NF = **1**

NEL (start), NEL (end), NAC, NDAC

**121 130 3 50**

NF = 0	End of Generation
1	Generate Element Activity / Deactivity

NF = **0**

User inputs are **bold**.

**Table 9.3** Listing of output file CARDS.Out

* NEL	NAC	NDAC
101	0	6
102	0	6
103	0	6
104	0	6
105	0	6
106	0	6
107	0	6
108	0	6
109	0	6
110	0	6
111	0	6
112	0	6
113	0	6
114	0	6
115	0	6
116	0	6
117	0	6
118	0	6
119	0	6
120	0	6
*		
121	3	50
122	3	50
123	3	50
124	3	50
125	3	50
126	3	50
127	3	50
128	3	50
129	3	50
130	3	50
* NFAD =	30	



## 10.1 LOAD-2D

LOAD-2D is the pre-processing program which can be used to generate initial head, external water flow, specified head and potential seepage face boundary. For the detailed description of input parameters, refer to section 11 of User's Manual.

LOAD-2D can be selected in the following order:

Run → Load Generator → Load 2D

When you select LOAD-2D, Load Generation Dialog will be displayed as in Figure 10.1. You need to specify input file names for Load and Mesh Data.

### 10.1.1 Example 1

Example 1 is to show most of load generations related to seepage problem as schematically shown in Figure 10.2. This problem is the same as SMAP-W2 Verification Problem 4 which is the axially symmetric well subjected to sudden drawdown of left side water table to the bottom of upper block.

Left side surface of upper block represents potential seepage face boundary, left side surface of lower block represents total head of 0.305m and the right side surface represents total head of 1.22m. Initial total heads are constant value of 1.22m over the whole region. Two different load time histories for left and right side water tables are considered.

Mesh Data contains information for nodal coordinates and element indexes. VP4\_NB.Mes represents Mesh Data graphically shown in Figure 10.3. Load Data contains information for loads to be generated. Load\_W2.dat in Table 10.1, has been prepared according to LOAD-2D User's Manual.

## 10-2 LOAD-2D Example Problem

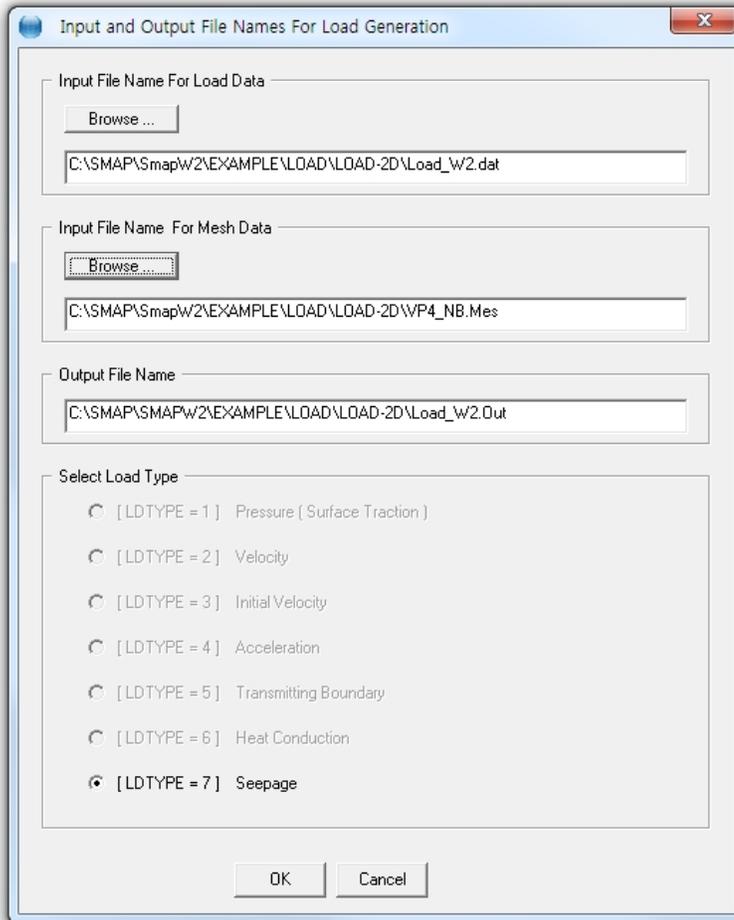


Figure 10.1 Load generation dialog

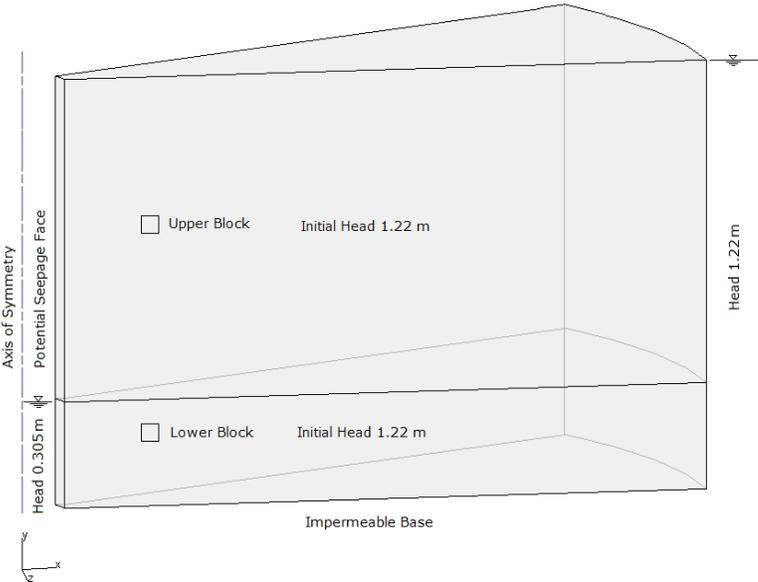
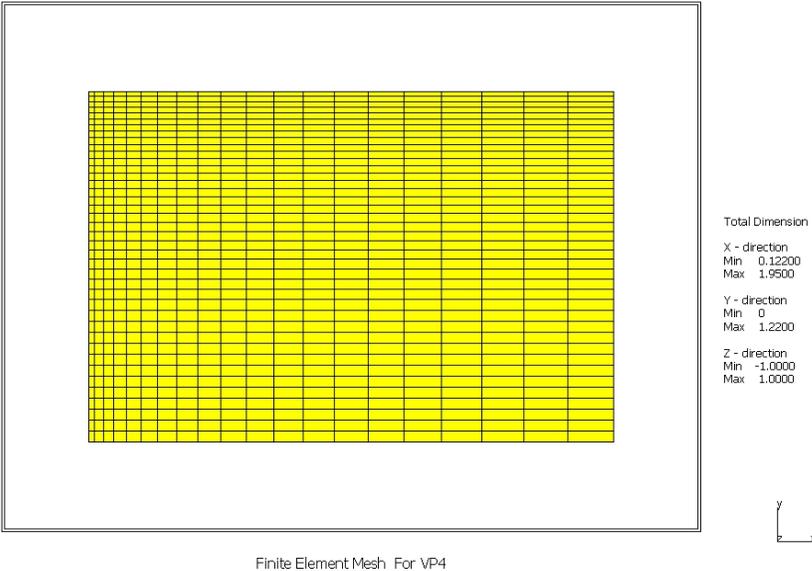


Figure 10.2 Schematic view of load for Example 1



Finite Element Mesh For VP4

Figure 10.3 Finite element mesh for Example 1

**Table 10.1** Listing of load input file Load\_W2.dat for Example 1

```

* LOAD-W2  INPUT
* CARD 1.1
* TITLE
  EXAMPLE 1  LOAD-W2 [LDTYPE = 7]
* CARD 1.2
* NCTYPE
  1
* =====
* CARD 2.1
* NUMLS
  3
* -----
* Potential Seepage Face
* CARD 2.2.1
* LSNO  LSTYPE (Node Group)
  1      3
* CARD 2.2.4
* NUMNODG
  1
* Upper Block Left Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  1    1    33   0    1
* -----
* Total Head 1
* CARD 2.2.1
* LSNO  LSTYPE (Node Group)
  2      3
* CARD 2.2.4
* NUMNODG
  1
* Lower Block Left Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  694  1    8    0    1
* -----
* Total Head 2
* CARD 2.2.1
* LSNO  LSTYPE (Node Group)
  3      3

```

## 10-6 LOAD-2D Example Problem

---

```
* CARD 2.2.4
* NUMNODG
  2
* Upper Block Right Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  661  1   33  0   1
* Lower Block Right Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  854  1   8   0   1
* =====
* CARD 3.1
* NUMLF
  2
* -----
* INITIAL HEAD
* CARD 3.2.1
* LFNO
  1
* CARD 3.2.2
* A-0      A-X      A-Y
  1.22     0.0     0.0
* -----
* CF
* CARD 3.2.1
* LFNO
  2
* CARD 3.2.2
* A-0      A-X      A-Y
  1.0      0.0     0.0
* =====
* CARD 4.1
* NUMLH
  2
* -----
* CARD 4.2.1
* LHNO
  1
* CARD 4.2.2
* NUMTP
  2
```

```
* CARD 4.2.3
* T1      T2
  0.0    1000.
* CARD 4.2.4
* C1      C2
  0.305  0.305
* -----
* CARD 4.2.1
* LHNO
  2
* CARD 4.2.2
* NUMTP
  2
* CARD 4.2.3
* T1      T2
  0.0    1000.
* CARD 4.2.4
* C1      C2
  1.22   1.22
* =====
* INITIAL HEAD
* CARD 5.1
* IBTYPE
  1
* CARD 5.1-1
* LFNO_IH  LHED_IH
  1        0
* -----
* POTENTIAL SEEPAGE FACE
* CARD 5.1
* IBTYPE
  6
* CARD 5.1-6
* LSNO_PS  LFNO_PS  LHNO_PS
  1        2        0
* -----
* TOTAL HEAD 1
* CARD 5.1
* IBTYPE
  5
* CARD 5.1-6
* LSNO_HB  LFNO_HB  LHNO_HB  LHED_HB
  2        2        1        0
```

## 10-8 LOAD-2D Example Problem

---

```
* -----
* TOTAL HEAD 2
* CARD 5.1
* IBTYPE
  5
* CARD 5.1-6
* LSNO_HB  LFNO_HB  LHNO_HB  LHED_HB
  3         2         2         0
* -----
* END
* CARD 5.1
* IBTYPE
  0
* -----
* END OF INPUT DATA
```

The output file [Load\\_W2.out](#) contains load time histories for total heads for left and right boundary surfaces. The format of the generated load output is compatible to the format of Card Group 9.4 in SMAP-W2 main input.

The output file [LoadingSurface.out](#) contains all nodes representing flow sections where flow rates are computed. The format of the generated load output is compatible to the format of Card Group 10.8 in SMAP-W2 main input.

For IBTYPE = 1, 4, 5, or 6, specified initial heads or boundary conditions are saved in mesh file ([NewMeshFile.Mes](#)).

## 10.2 LOAD-3D

LOAD-3D is the pre-processing program which can be used to generate initial head, external water flow, specified head and potential seepage face boundary. For the detailed description of input parameters, refer to section 11 of User's Manual.

LOAD-3D can be selected in the following order:

Run → Load Generator → Load 3D

When you select LOAD-3D, Load Generation Dialog will be displayed as in Figure 10.4. You need to specify input file names for Load and Mesh Data.

### 10.2.1 Example 1

Example 1 is to show most of load generations related to seepage problem as schematically shown in Figure 10.5. This problem is the same as SMAP-W3 Verification Problem 4 which is the axially symmetric well subjected to sudden drawdown of left side water table to the bottom of upper block.

Left side surface of upper block represents potential seepage face boundary, left side surface of lower block represents total head of 0.305m and the right side surface represents total head of 1.22m. Initial total heads are constant value of 1.22m over the whole region. Two different load time histories for left and right side water tables are considered.

Mesh Data contains information for nodal coordinates and element indexes. VP4\_NB.Mes represents Mesh Data graphically shown in Figure 10.6. Load Data contains information for loads to be generated. Load\_W3.dat in Table 10.2, has been prepared according to LOAD-3D User's Manual.

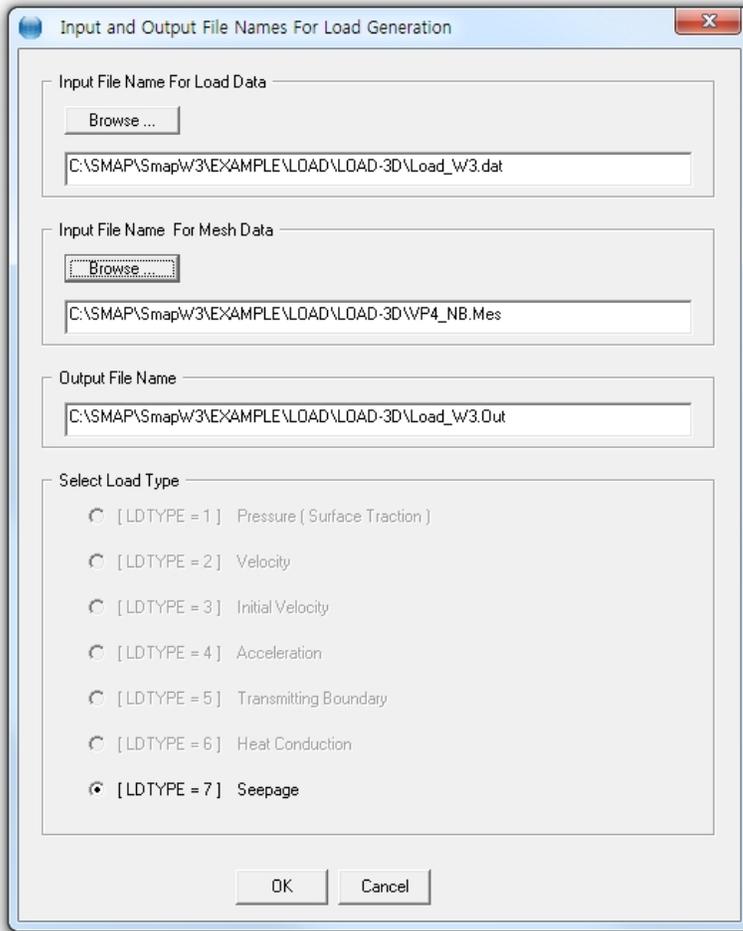


Figure 10.4 Load generation dialog

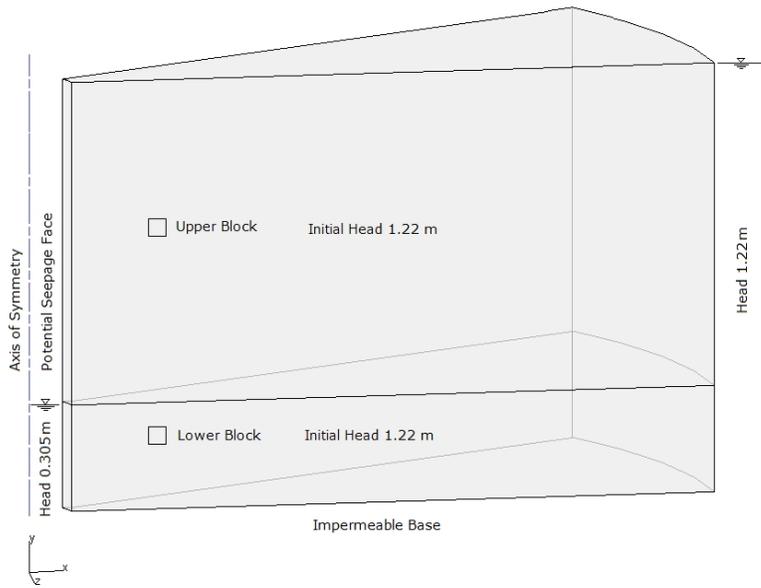
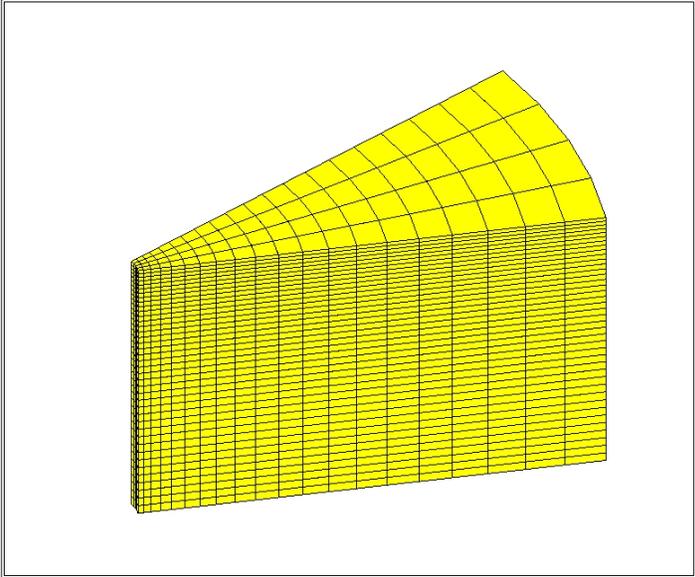


Figure 10.5 Schematic view of load for Example 1



Total Dimension  
X - direction  
Min 0.10710  
Max 1.9500  
Y - direction  
Min 0  
Max 1.2200  
Z - direction  
Min -0.93490  
Max 0



Finite Element Mesh For VP4

Figure 10.6 Finite element mesh for Example 1

**Table 10.2** Listing of load input file Load\_W3.dat for Example 1

```
* LOAD-W3 INPUT
* CARD 1.1
* TITLE
  EXAMPLE 1  LOAD-W3 [LDTYPE = 7]
* =====
* CARD 2.1
* NUMLS
  3
* -----
* Potential Seepage Face
* CARD 2.2.1
* LSNO  LSTYPE (Node Group)
  1      5
* CARD 2.2.4
* NUMNODG
  1
* Upper Block Left Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  1    1    33   693  5
* -----
* Total Head 1
* CARD 2.2.1
* LSNO  LSTYPE (Node Group)
  2      5
* CARD 2.2.4
* NUMNODG
  1
* Lower Block Left Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  3466 1     8   168  5
* -----
* Total Head 2
* CARD 2.2.1
* LSNO  LSTYPE (Node Group)
  3      5
```

```
* CARD 2.2.4
* NUMNODG
  2
* Upper Block Right Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  661  1   33  693  5
* Lower Block Right Surface
* CARD 2.2.5
* NSR  JCR  NJR  ICR  NIR
  3626 1   8   168  5
* =====
* CARD 3.1
* NUMLF
  2
* -----
* INITIAL HEAD
* CARD 3.2.1
* LFNO
  1
* CARD 3.2.2
* A-0      A-X      A-Y      A-Z
  1.22     0.0     0.0     0.0
* -----
* CF
* CARD 3.2.1
* LFNO
  2
* CARD 3.2.2
* A-0      A-X      A-Y      A-Z
  1.0      0.0     0.0     0.0
* =====
* CARD 4.1
* NUMLH
  2
* -----
* CARD 4.2.1
* LHNO
  1
* CARD 4.2.2
* NUMTP
  2
```

```
* CARD 4.2.3
* T1      T2
  0.0     1000.
* CARD 4.2.4
* C1      C2
  0.305   0.305
* -----
* CARD 4.2.1
* LHNO
  2
* CARD 4.2.2
* NUMTP
  2
* CARD 4.2.3
* T1      T2
  0.0     1000.
* CARD 4.2.4
* C1      C2
  1.22    1.22
* =====
* INITIAL HEAD
* CARD 5.1
* IBTYPE
  1
* CARD 5.1-1
* LFNO_IH  LHED_IH
  1         0
* -----
* POTENTIAL SEEPAGE FACE
* CARD 5.1
* IBTYPE
  6
* CARD 5.1-6
* LSNO_PS  LFNO_PS  LHNO_PS
  1         2         0
* -----
* TOTAL HEAD 1
* CARD 5.1
* IBTYPE
  5
* CARD 5.1-6
* LSNO_HB  LFNO_HB  LHNO_HB  LHED_HB
  2         2         1         0
```

```
* -----  
* TOTAL HEAD 2  
* CARD 5.1  
* IBTYPE  
  5  
* CARD 5.1-6  
* LSNO_HB  LFNO_HB  LHNO_HB  LHED_HB  
  3         2         2         0  
* -----  
* END  
* CARD 5.1  
* IBTYPE  
  0  
* -----  
* END OF INPUT DATA
```

The output file [Load\\_W3.out](#) contains load time histories for total heads for left and right boundary surfaces. The format of the generated load output is compatible to the format of Card Group 9.4 in SMAP-W3 main input.

The output file [LoadingSurface.out](#) contains all nodes representing flow sections where flow rates are computed. The format of the generated load output is compatible to the format of Card Group 10.8 in SMAP-W3 main input.

For IBTYPE = 1, 4, 5, or 6, specified initial heads or boundary conditions are saved in mesh file ([NewMeshFile.Mes](#)).

## XY Graph Example Problem

**XY Graph** is a two-dimensional graph consisting of lines connecting each pair of data points, which can be plotted by **PLOT XY** or **EXCEL**. **XY Graph User's Manual** describes all the basic functions associated with XY graph creation and modifications.

Two example problems are presented:

### 1. New Graph

Shows step-by-step procedure to create and modify XY graph.

Main actions:

- Access XY graph
- Edit initial Draft XY
- Modify XY graph by Edit dialog
- Open XY graph on Excel Spreadsheet

### 2. SMAP Result

Plots SMAP results specified in Card Group 12 in SMAP Post File.

Main actions:

- Execute SMAP-W3 example
- Access SMAP result
- Access PLOT XY in Plot menu
- Modify XY graph by Edit dialog
- Open XY graph on Excel Spreadsheet

### 11.1 New Graph

The main objective of this first example is to show the step-by-step procedure to create and modify XY graph.

This example consists of the following main actions:

- Access XY graph
- Edit initial Draft XY
- Modify XY graph by Edit dialog
- Open XY graph on Excel Spreadsheet

#### Step 1: Access XY Graph (New)

Access [XY Graph](#) by selecting following items in [SMAP](#) (Figure 11.1):  
[Plot](#) → [XY](#) → [PLOT XY](#) → [New](#)

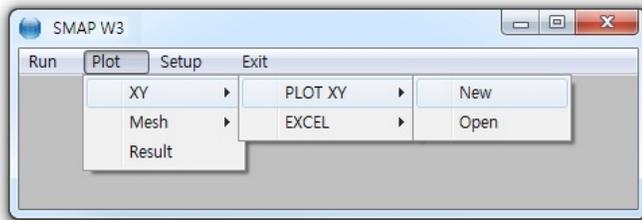


Figure 11.1 Accessing XY graph (New)

#### Step 2: Edit Initial Draft XY

Once selected, initial default file [XY.dat](#) will be opened by [Notepad](#) as listed in Table 11.1.

Edit the first plot in this default file as listed in Table 11.2.  
And then save and exit.

Modified graph will be displayed on [PLOT XY](#) drawing board as shown in Figure 11.2.

Table 11.1 Draft XY Data (Initial Default [File XY.dat](#))

<b>Plot No. 1</b>	
Sub Title 1	
XLabel-1	
YLabel-1	
0	10
100	20
.000000E+00	.123456E+06
Curve 1	
Legend	
10,	20
90,	30
.000000E+00	.123456E+06
Curve 2	
Legend	
.000000E+00	.987654E+06
<b>Plot No. 2</b>	
Sub Title 2	
XLabel-2	
YLabel-2	
0	100
1000	200
.000000E+00	.123456E+06
Curve 1	
Legend	
100	200
900	300
.000000E+00	.123456E+06
Curve 2	
Legend	
.000000E+00	.987654E+06
<b>Plot No. 3</b>	
Sub Title 3	
XLabel-3	
YLabel-3	
0	100
1000	200
.000000E+00	.123456E+06
Curve 1	
Legend	
200,	200
900,	300
.000000E+00	.123456E+06
Curve 2	
Legend	
.000000E+00	.987654E

## 11-4 XY Graph Example

---

Table 11.2 Modified Draft XY Data ([File XY.dat](#))

```
Example 1
Stress History
Time (Sec)
Stress (MPa)
0      10
100    20
.000000E+00 .123456E+06
Vertical
Stress
0      20
100    30
.000000E+00 .123456E+06
Horizontal
Stress
.000000E+00 .987654E+06
Plot No. 2
Sub Title 2
XLabel-2
YLabel-2
0      100
1000   200
.000000E+00 .123456E+06
Curve 1
Legend
100    200
900    300
.000000E+00 .123456E+06
Curve 2
Legend
.000000E+00 .987654E+06
Plot No. 3
Sub Title 3
XLabel-3
YLabel-3
0      100
1000   200
.000000E+00 .123456E+06
Curve 1
Legend
200,   200
900,   300
.000000E+00 .123456E+06
Curve 2
Legend
.000000E+00 .987654E
```

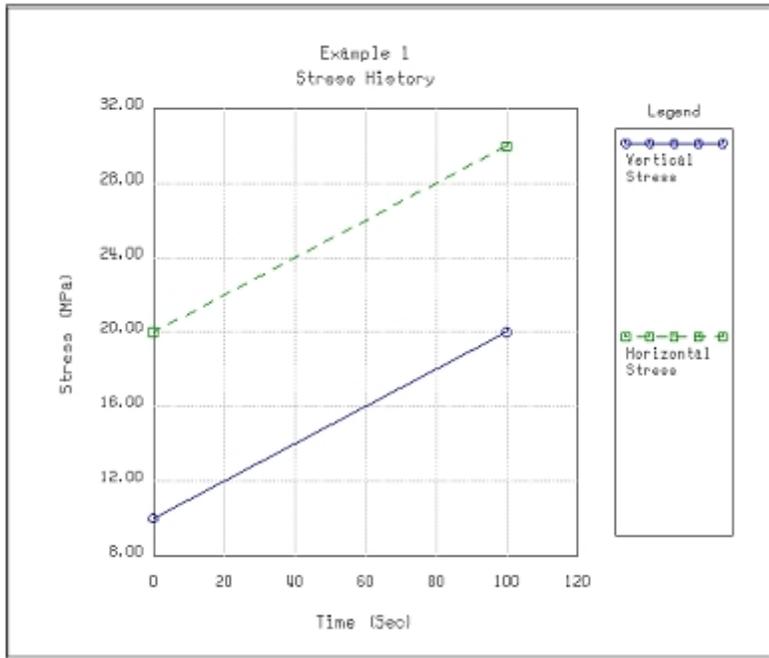


Figure 11.2 Modified graph on PLOT XY

### Step 3: Modify XY Graph by Edit Dialog

Access [Edit dialog](#) by clicking the [Edit](#) menu in [PLOT XY](#) (Figure 11.3):

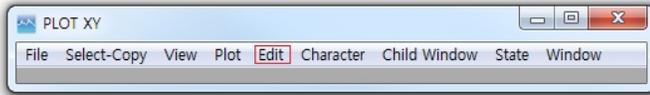


Figure 11.3 Edit menu in PLOT XY

[Edit dialog](#) will be displayed as shown in Figure 11.4.

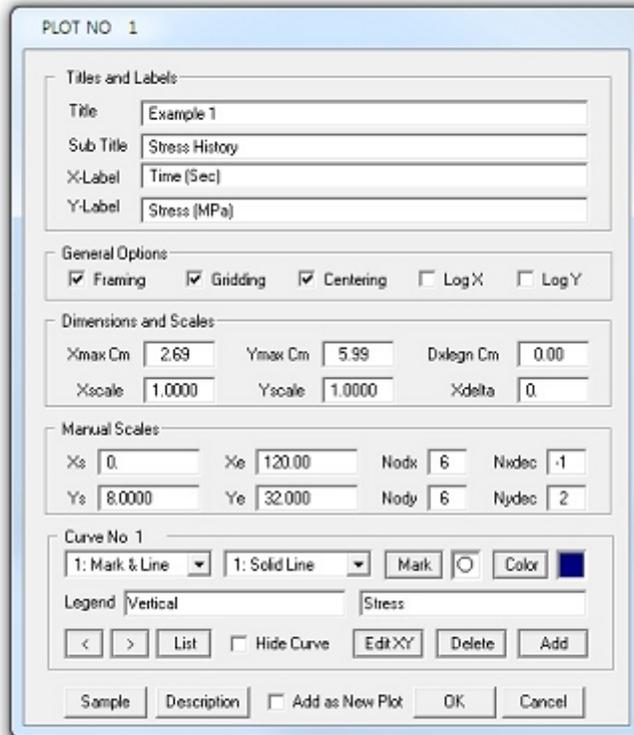


Figure 11.4 Edit dialog

There are many different options available for changing view of XY graphs as described in detail in Section 12.3 in [XY Graph User's Manual](#).

Here, change the color of the first curve into Red.  
 Click [Color](#) button and select Red from [Color Palette dialog](#).  
 Then Red color will be updated for first curve as shown in Figure 11.5.

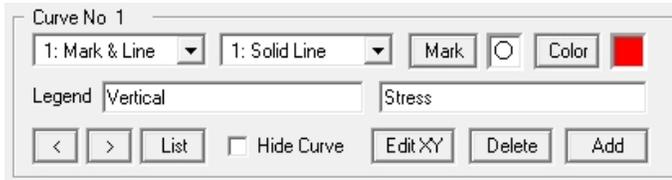


Figure 11.5 Updated red color in Edit dialog

Click [OK](#) button in [Edit dialog](#).  
 Then updated plot will be displayed on [PLOT XY](#) as in Figure 11.6.

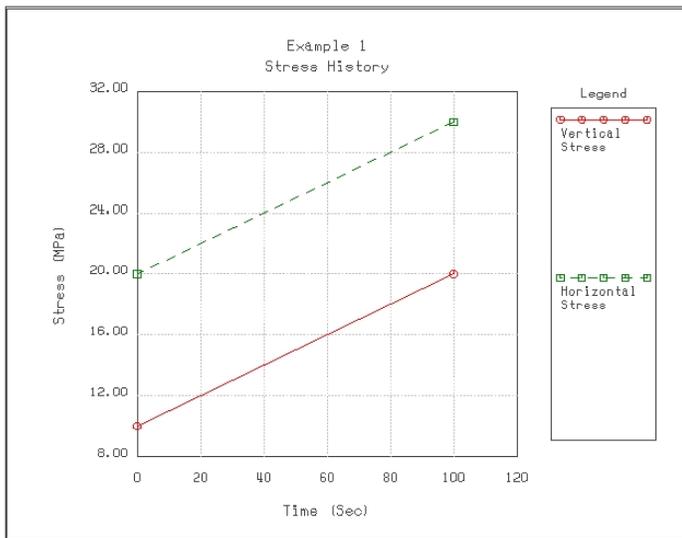


Figure 11.6 Updated first curve on PLOT XY

## 11-8 XY Graph Example

### Step 4: Open XY Graph on Excel Spreadsheet

Access **XY Graph** by selecting following items in **SMAP** (Figure 11.7):  
**Plot** → **XY** → **EXCEL** → **Open**

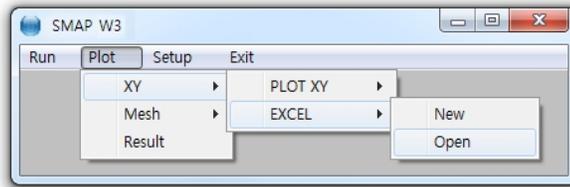


Figure 11.7 Accessing XY graph on Excel (Open)

Open **XY.dat** in the current working directory.

XY graph will be displayed on **Excel Spreadsheet** as in Figure 11.8.

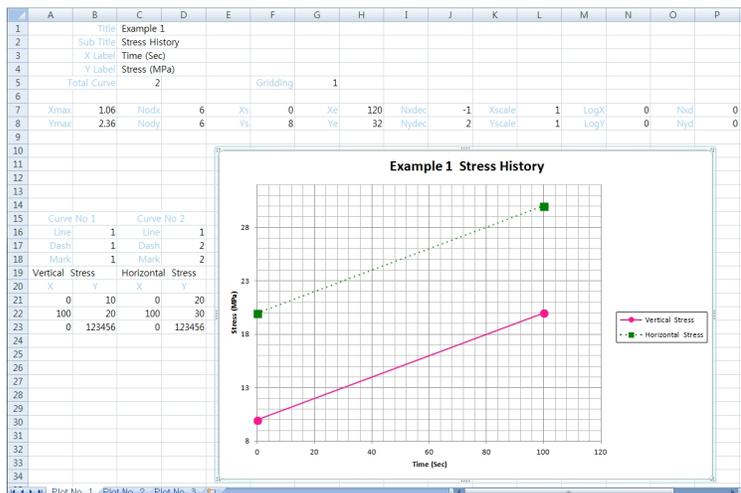


Figure 11.8 XY graph on Excel spreadsheet

Refer to more samples in the following directory:

C:\Smap \SmapW3 \Example \XY\_Graph \Excel XY Graph Sample.docx

## 11.2 SMAP Result

The main objective of this second example is to show step-by-step procedure to plot SMAP results specified in Card Group 12 in SMAP Post File. This example involves SMAP-W3 Example Problem 1 (1-D Transient Linear Consolidation).

This example consists of the following main actions:

- Execute SMAP-W3 example
- Access SMAP result
- Access PLOT XY in Plot menu
- Modify XY graph by Edit dialog
- Open XY graph on Excel Spreadsheet

### Step 1: Execute SMAP-W3 Example

Execute [SMAP-W3](#) by selecting the following menu items in [SMAP](#) (Figure 11.9): [Run](#) → [Smap](#) → [Execute](#)

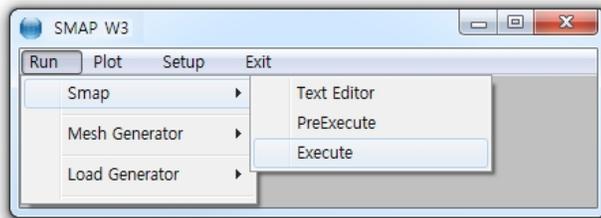


Figure 11.9 Execute SMAP-W3 example problem

Note that [SMAP-W3 Example Problem 1](#) includes XY graph specified in Card Group 12 in SMAP Post File [Vp1.Pos](#) as listed in Table 11.3

### Step 2: Access SMAP Result

Access [SMAP Result](#) by selecting the following menu items in [SMAP](#) : [Plot](#) → [Result](#)

## 11-10 XY Graph Example

---

Table 11.3 SMAP-W3 post file (File Vp1.Pos)

```
* PLOT-2D Information
* CARD 11.1
* NPTYPE
  0
* PLOT-XY Information
* CARD 12.1
* IPTYPE
  3
* Card 12.4.1
* IPLOT
  1
* Card 12.4.2
* NOTM
  2
* Card 12.4.3
* TLIST1  TLIST2  ...
  3.71    37.1
* Card 12.4.4
* NDPQ
  1
* Card 12.4.5
* KY2
  51
* Card 12.4.6
* ISCALD  ILTNUM  XSTART
  1        1        0.25
*
* Card 12.4.7
  2
* NSTAR   NINCR   NPONT
  1        1        20
  0
* Card 12.4.8
* TPFAC   SDFAC
  1        1
* Card 12.4.9
* TITLE / X-LABEL / Y-LABEL
  Profiles of Pore Water Pressure (SMAP-W2)
  M
  Pore Water Pressure (t/m2)
* CARD 12.1
* IPTYPE
  0
* End of Data
```

**Step 3: Access PLOT XY in Plot Menu**

Select **PLOT XY** in **Plot Menu dialog** in Figure 11.10.

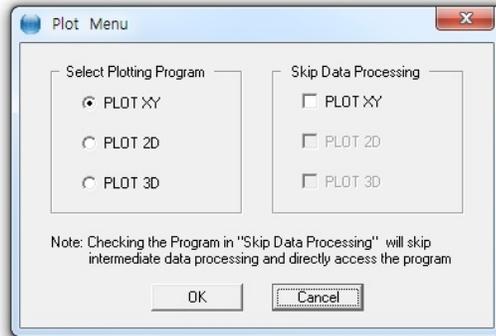


Figure 11.10 Plot menu dialog

**Step 4: Modify XY Graph by Edit Dialog**

Once XY graph is displayed on **PLOT XY**, access **Edit dialog** by clicking the **Edit** menu in **PLOT XY** as shown in Figure 11.11

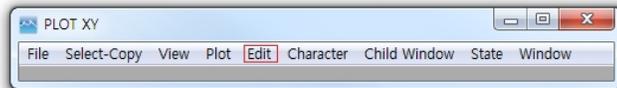


Figure 11.11 Edit menu in PLOT XY

## 11-12 XY Graph Example

Modify **Edit dialog** as shown in Figure 11.12.

The main modification is to change scales and color in XY graph.

Click **OK** button in **Edit dialog**.

PLOT NO 1

Titles and Labels

Title Profiles of Pore Water Pressure (SMAP-W2)

Sub Title AT TIMES .371000E+01 .371000E+02

X-Label M

Y-Label Pore Water Pressure (t/m2)

General Options

Framing  Gridding  Tick Mark  Log X  Log Y

Dimensions and Scales

Xmax Cm 12.70 Ymax Cm 12.70 Dxlegn Cm 0.00

Xscale 1.0000 Yscale 1.0000 Xdelta 0.

Manual Scales

Xs 0. Xe 10.000 Nodx 5 Nxdec -1

Ys 0. Ye 20.000 Nody 4 Nydec -1

Curve No 1

1: Mark & Line 1: Solid Line Mark  Color

Legend T = .3710E+01

< > List  Hide Modify XY Edit XY Delete Add

Sample Description  Add as New Plot OK Cancel

Figure 11.12 Edit dialog

Modified XY graph is shown in figure 11.13.

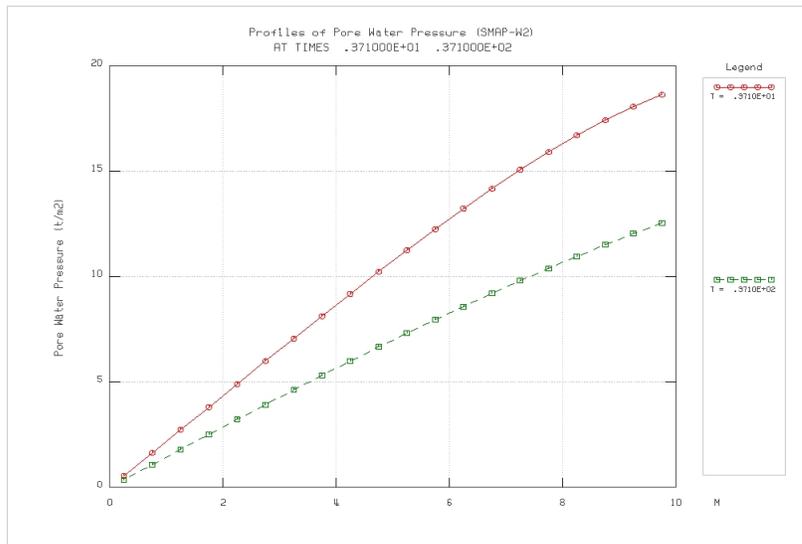


Figure 11.13 XY graph on PLOT XY

Refer to more samples in the following directory:

C:\Smapp\SmappW3\Example\XY\_Graph\PLOT XY Graph Sample.docx

## 11-14 XY Graph Example

### Step 5: Open XY Graph on Excel Spreadsheet

Access **XY Graph** by selecting following items in **SMAP** (Figure 11.14):  
**Plot** → **XY** → **EXCEL** → **Open**

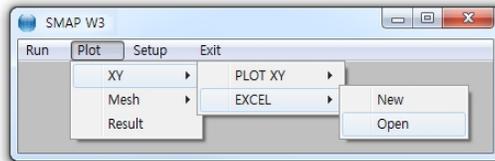


Figure 11.14 Accessing XY graph on Excel (Open)

Open **PlotXy.Lin** in the current working directory.  
XY graph will be displayed on **Excel Spreadsheet** as in Figure 11.15.

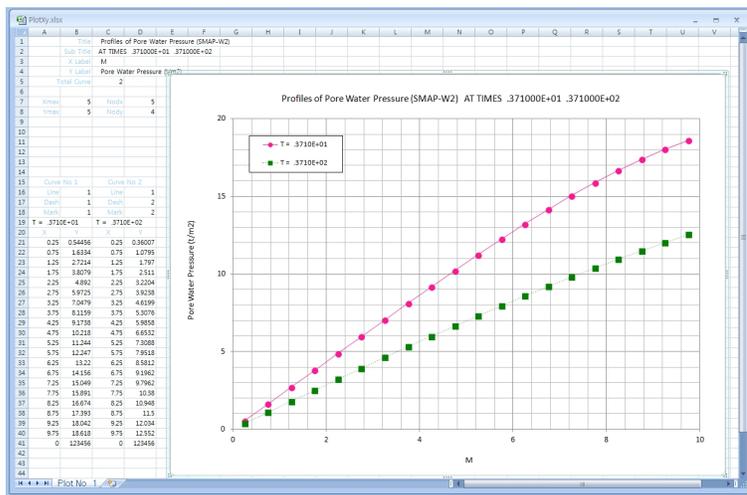


Figure 11.15 XY graph on Excel spreadsheet

Refer to more samples in the following directory:

C:\Smap \SmapW3 \Example \XY\_Graph \Excel XY Graph Sample.docx

## SWCC Example Problem

SWCC program supports following SWCC models:  
van Genuchten (1980), Fredlund and Xing (1994)  
and Brutsaert (1966) & Gardner (1958)

Graphical output file:

**SWCC.Lin** plots following graphs as a function of soil suction:

- Volumetric water content
- Normalized volumetric water content
- Specific moisture capacity
- Relative hydraulic conductivity
- Absolute hydraulic conductivity in log scale
- Absolute hydraulic conductivity in arithmetic scale
- Volumetric water content vs absolute hydraulic conductivity

Text output files:

**PresfunctionM.dat**

Permeability and specific moisture capacity

**PresfunctionV.dat**

Permeability and volumetric water content

**PresfunctionA.dat**

Permeability, volumetric water content and water capacity

Note:

Graphical file SWCC.Lin can be plotted by PLOT-XY.

Text output files can be used as input data for SMAP-F2/W2/W3.

## 12-2 SWCC Example

### Prepare Input File

This example represents SM soil data fitted to van Genuchten Model by M.W. Gui, etc (Ref. Comparison of Two Water Storage Functions of Soil on Pore Water Pressure of Earth-Filled Dam Under Changing Environment, 28th International Symposium on Automation and Robotics in Construction, ISARC 2011 - Seoul, Korea, Republic of Duration: 29 Jun 2011 → 2 Jul 2011)

Input file in Table 12.1 is prepared according to [SWCC Users Manual](#).

### Access SWCC

Access [SWCC](#) by selecting following items in [SMAP](#).  
[Run](#) → [Swcc Analysis](#) → [Swcc](#)

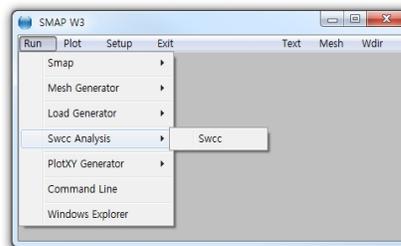


Figure 12.1 Accessing SWCC

### Select Input File

Once clicked SWCC, browse input file as shown in Figure 12.2.

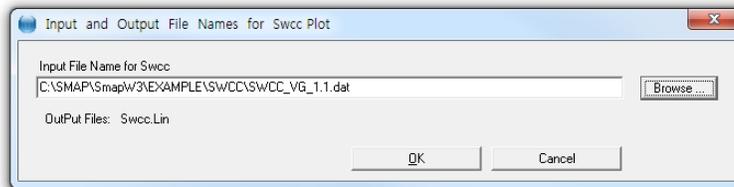


Figure 12.2 Selecting SWCC input file

### Output Files

Text output file is listed in Table 12.2.

Graphical outputs are shown in Figures 12.3, 12.4 and 12.5.

Table 12.1 SWCC input file (SWCC\_VG1.1.dat)

```

* CARD 1.
* TITLE
  van Genuchten Model (1980)
* SM soil from Table 1 in Ref. 6
* CARD 2
* MATFN  MW(m2/kN)  GW(kN/m3)  KSAT(m/d)  XSmin  XEmax  DLZ
  11      5.0E-05    9.81      0.6048   0.01   1e+06  0.02
* CARD 3
* VWCsat  VWCres   a      n      m      Uswcc  SCFac  Gwm
  0.35    0.0     0.06816  1.411  0.2913  0      1      9.81
* END OF DATA

```

Table 12.2 SWCC output file (PresFunctionA.dat)

```

* CARD 9.5.1
* NWPRF      NWPR      IWPF
  1          402      1
*
* CARD 9.5.2
*   N   H [L]      TH [L3/L3]      AK [L/T]      CA [1/L]
  1   .000000E+00 .350000E+00 .604800E+00 .000000E 00
  2   .101937E-02 .349997E+00 .545881E+00 .480503E-02
  3   .106741E-02 .349996E+00 .544785E+00 .489682E-02
  4   .111771E-02 .349996E+00 .543669E+00 .499037E-02
  5   .117039E-02 .349996E+00 .542532E+00 .508571E-02
  6   .122555E-02 .349995E+00 .541375E+00 .518287E-02
  7   .128331E-02 .349995E+00 .540197E+00 .528188E-02
  8   .134379E-02 .349995E+00 .538998E+00 .538278E-02
  9   .140712E-02 .349995E+00 .537778E+00 .548561E-02
  -   -           -           -           -
  396 .773259E+05 .404292E-02 .452231E-08 .214901E-07
  397 .809701E+05 .396712E-02 .451766E-08 .201380E-07
  398 .847861E+05 .389273E-02 .451285E-08 .188711E-07
  399 .887820E+05 .381974E-02 .450791E-08 .176838E-07
  400 .929661E+05 .374812E-02 .450282E-08 .165713E-07
  401 .973475E+05 .367784E-02 .449758E-08 .155287E-07
  402 .101935E+06 .360888E-02 .449221E-08 .145517E-07
* END OF DATA

```

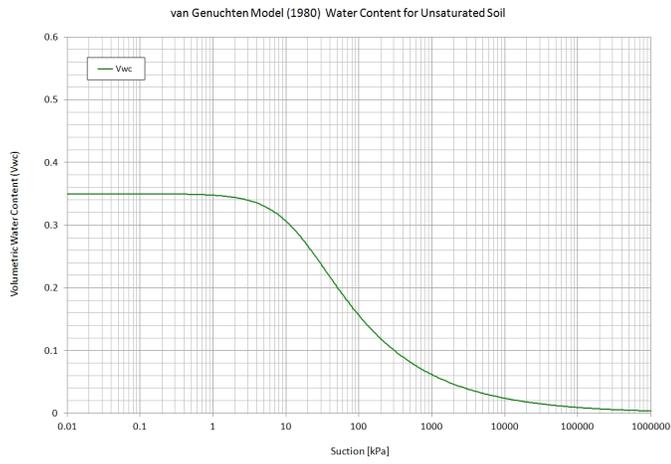


Figure 12.3 Volumetric water content

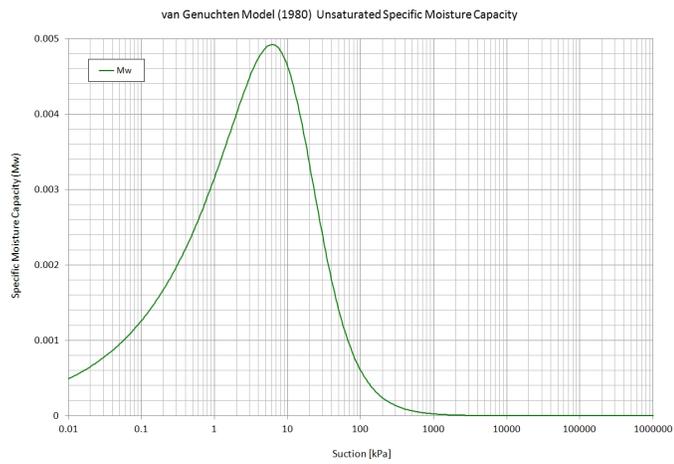


Figure 12.4 Specific moisture capacity

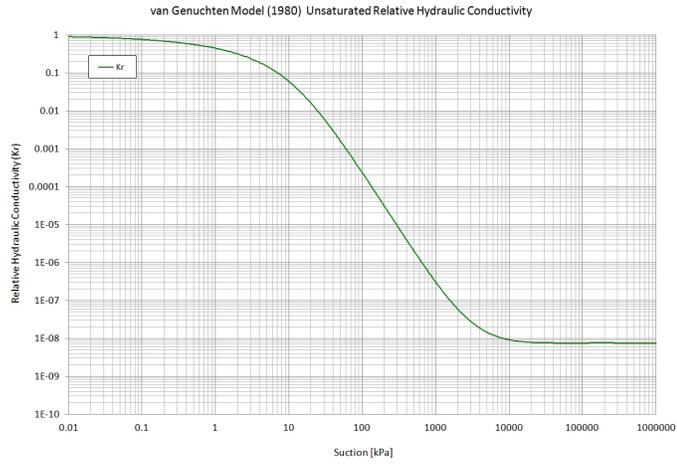


Figure 12.5 Relative hydraulic conductivity



Go to [Edit](#) > [Preferences](#) > [Page Display](#) > Uncheck [Enhance Thin Lines](#)

# SMAP<sup>®</sup> - W3

Structure Medium Analysis Program  
3-D Seepage Analysis

Theory



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**Contents**

<b>1. Introduction</b>	
1.1 Introduction .....	1-1
<b>2. Finite Element Formulations</b>	
2.1 Introduction .....	2-1
2.2 Finite Element Formulation .....	2-2
<b>3. SWCC Models</b>	
3.1 SWCC Models .....	3-1
3.1.1 Introduction .....	3-1
3.1.2 van Genuchten (1980) .....	3-2
3.1.3 Fredlund and Xing (1994) .....	3-3
3.1.4 Brutsaert(1966) and Gardner (1958) .....	3-4
3.1.5 Simple Gardner (1958) .....	3-5
<b>4. Reference</b> .....	4-1



## Introduction

### 1.1 Introduction

This paper introduces the nonlinear finite element computer program SMAP-W3 developed by COMTEC RESEARCH. The program has specific applications for modeling nonlinear transient seepage problems in saturated and unsaturated soils including potential seepage face. Other practical applications of SMAP-W3 include designing hydraulic structures and seepage through dams, embankments, retaining walls and slopes.

Section 2 describes derivation of finite element formulation for seepage analysis in three-dimensional body. We set the mass balance in control volume, construct global mass equilibrium equation using the Galerkin residual method and then convert volume integration into surface integration using Gauss divergence theorem. Finally we construct finite element formulation by discretizing the continuous system using shape functions and numerical integration technique.

Section 3 presents SWCC models which represent Soil Water Characteristic Curve where unsaturated volumetric water content is expressed as a function of matric suction.



## Finite Element Formulation

### 2.1 Introduction

Section 2.2 derives finite element formulation for seepage in three-dimensional body. First, we set the flow balance in control volume as shown in Figure 2.1. Then we construct global flow equilibrium equation using the Galerkin's residual method. Then we convert volume integration into surface integration using Gauss divergence theorem. Finally we construct finite element formulation by discretizing the continuous system using shape functions and numerical integration technique.

## 2.2 Finite Element Formulation

For a differential cubic element volume  $dv = dx \, dy \, dz$

See Figure 2.1 for flow rate in x direction.

$$\begin{aligned}\dot{Q}_x &: \text{Flow rate in x direction} \\ \dot{Q}_y &: \text{Flow rate in y direction} \\ \dot{Q}_z &: \text{Flow rate in z direction}\end{aligned}$$

Flow rate by hydraulic conduction (J. B. J. Fourier, 1822)

$$\begin{aligned}\dot{Q}_x &= -k_x (dy \cdot dz) \partial H / \partial x \\ \dot{Q}_y &= -k_y (dx \cdot dz) \partial H / \partial y \\ \dot{Q}_z &= -k_z (dx \cdot dy) \partial H / \partial z\end{aligned}\tag{2.1}$$

Derivatives of Equation 2.1

$$\begin{aligned}\partial \dot{Q}_x / \partial x &= -k_x (dy \cdot dz) \partial^2 H / \partial x^2 \\ \partial \dot{Q}_y / \partial y &= -k_y (dx \cdot dz) \partial^2 H / \partial y^2 \\ \partial \dot{Q}_z / \partial z &= -k_z (dx \cdot dy) \partial^2 H / \partial z^2\end{aligned}\tag{2.2}$$

Flow balance within control volume  $dx \, dy \, dz$  during  $dt$

$$Q_I + Q_G = Q_O + Q_R\tag{2.3}$$

Flow coming into the control volume

$$Q_I = \dot{Q}_x \cdot dt + \dot{Q}_y \cdot dt + \dot{Q}_z \cdot dt\tag{2.4}$$

Flow generated within the control volume

$$Q_G = \dot{q}_G \cdot dv \cdot dt\tag{2.5}$$

Flow coming out from the control volume

$$\begin{aligned}Q_O &= (\dot{Q}_x + (\partial \dot{Q}_x / \partial x) \cdot dx) \cdot dt \\ &+ (\dot{Q}_y + (\partial \dot{Q}_y / \partial y) \cdot dy) \cdot dt \\ &+ (\dot{Q}_z + (\partial \dot{Q}_z / \partial z) \cdot dz) \cdot dt\end{aligned}\tag{2.6}$$

Flow remained within volume resulted in total head increase

$$Q_R = \lambda \cdot dV \cdot (\partial H / \partial t) \cdot dt \quad \text{where } \lambda = m_w \gamma_w \quad (2.7)$$

Substituting Equations 2.1 and 2.2 into 2.3 with 2.4 through 2.7

$$k_x (\partial^2 H / \partial x^2) + k_y (\partial^2 H / \partial y^2) + k_z (\partial^2 H / \partial z^2) + \dot{q}_G - \lambda (\partial H / \partial t) = 0 \quad (2.8)$$

Assume total head field using shape functions

$$\begin{aligned} H &= [N_i] [H_i] \\ [N_i] &= [N_1 \ N_2 \ N_3 \ N_4 \ N_5 \ N_6 \ N_7 \ N_8] \\ [H_i]^T &= [H_1 \ H_2 \ H_3 \ H_4 \ H_5 \ H_6 \ H_7 \ H_8] \end{aligned} \quad (2.9)$$

Residual by applying Equation 2.9 into 2.8

$$R = (k_x \partial [N_i, x] / \partial x + k_y \partial [N_i, y] / \partial y + k_z \partial [N_i, z] / \partial z) [H_i] + \dot{q}_G - \lambda [N_i] [\dot{H}_i] \quad (2.10)$$

Applying Galerkin's weighted residual method

$$\int_V [N_i]^T \cdot R = 0 \quad : \quad i = 1 \text{ to } 8 \quad (2.11)$$

Divergence theorem

$$\int_V \mathbf{A} \cdot (\partial \mathbf{B} / \partial \mathbf{x}) \cdot dV = - \int_V \mathbf{B} \cdot (\partial \mathbf{A} / \partial \mathbf{x}) \cdot dV + \int_S \mathbf{A} \cdot \mathbf{B} \cdot dS \quad (2.12)$$

Divergence theorem for x component

$$\int_V [N_i]^T k_x (\partial [N_r, x] / \partial x) dV = - \int_V k_x [N_r, x]^T [N_r, x] dV + \int_S k_x [N_i]^T [N_r, x] n_x dS \quad (2.13)$$

Divergence theorem for y component

$$\int_V [N_i]^T k_y (\partial [N_r, y] / \partial y) dV = - \int_V k_y [N_r, y]^T [N_r, y] dV + \int_S k_y [N_i]^T [N_r, y] n_y dS \quad (2.14)$$

Divergence theorem for z component

$$\int_V [N_i]^T k_z (\partial [N_r z] / \partial z) dv = - \int_V k_z [N_r z]^T [N_r z] dv + \int_S k_z [N_i]^T [N_r z] n_z ds \quad (2.15)$$

Substituting Equations 2.10 into 2.11 with 2.13 through 2.15

$$[c] \cdot [\dot{H}_i] + [k] \cdot [H_i] = [\dot{q}_h] + [\dot{q}_B] \quad (2.16)$$

Element capacity matrix

$$[c] = \int_V \lambda [N_i]^T \cdot [N_i] dv \quad (2.17)$$

Element hydraulic conductivity matrix

$$[k] = \int_V k_x [N_r x]^T [N_r x] dv + \int_V k_y [N_r y]^T [N_r y] dv + \int_V k_z [N_r z]^T [N_r z] dv \quad (2.18)$$

Element flow generation vector

$$[\dot{q}_h] = \int_V [N_i]^T \cdot \dot{q}_G dv \quad (2.19)$$

Element specified boundary flow vector

$$\begin{aligned} [\dot{q}_B] &= \int_S [N_i]^T (k_x [N_r x] [H_i] n_x + k_y [N_r y] [H_i] n_y + k_z [N_r z] [H_i] n_z) ds \\ &= \int_S [N_i]^T (k_x (\partial H / \partial x) n_x + k_y (\partial H / \partial y) n_y + k_z (\partial H / \partial z) n_z) ds \\ &= \int_S [N_i]^T \cdot f_B \cdot ds \end{aligned} \quad (2.20)$$

Where  $f_B$  is specified flux on the element surface

Interpolation of x, y and z coordinates

$$\begin{aligned} x &= x(\xi, \eta, \zeta) = N_1(\xi, \eta, \zeta) x_1 + \dots + N_8(\xi, \eta, \zeta) x_8 \\ y &= y(\xi, \eta, \zeta) = N_1(\xi, \eta, \zeta) y_1 + \dots + N_8(\xi, \eta, \zeta) y_8 \\ z &= z(\xi, \eta, \zeta) = N_1(\xi, \eta, \zeta) z_1 + \dots + N_8(\xi, \eta, \zeta) z_8 \end{aligned} \quad (2.21)$$

Derivatives of shape functions wrt  $\xi, \eta, \zeta$  coordinates by chain rule

$$\begin{aligned} N_{1,r} \xi &= (N_{1,r} x) \cdot (x, \xi) + (N_{1,r} y) \cdot (y, \xi) + (N_{1,r} z) \cdot (z, \xi) \\ N_{1,r} \eta &= (N_{1,r} x) \cdot (x, \eta) + (N_{1,r} y) \cdot (y, \eta) + (N_{1,r} z) \cdot (z, \eta) \\ N_{1,r} \zeta &= (N_{1,r} x) \cdot (x, \zeta) + (N_{1,r} y) \cdot (y, \zeta) + (N_{1,r} z) \cdot (z, \zeta) \end{aligned} \quad (2.22)$$

$$\begin{bmatrix} N_{1,r} \xi \\ N_{1,r} \eta \\ N_{1,r} \zeta \end{bmatrix} = \begin{bmatrix} x, \xi & y, \xi & z, \xi \\ x, \eta & y, \eta & z, \eta \\ x, \zeta & y, \zeta & z, \zeta \end{bmatrix}^{-1} \begin{bmatrix} N_{1,r} x \\ N_{1,r} y \\ N_{1,r} z \end{bmatrix} \quad (2.23)$$

Derivatives of shape functions wrt  $x, y$  and  $z$  coordinates

$$\begin{bmatrix} N_{1,r} x \\ N_{1,r} y \\ N_{1,r} z \end{bmatrix} = \begin{bmatrix} x, \xi & y, \xi & z, \xi \\ x, \eta & y, \eta & z, \eta \\ x, \zeta & y, \zeta & z, \zeta \end{bmatrix}^{-1} \begin{bmatrix} N_{1,r} \xi \\ N_{1,r} \eta \\ N_{1,r} \zeta \end{bmatrix} \quad (2.24)$$

$N_{1,r}, N_{1,x}, N_{1,y}$  and  $N_{1,z}$  can be evaluated at integration point  $(\xi, \eta, \zeta)$

$$\begin{bmatrix} L_x(1) \\ L_y(1) \\ L_z(1) \end{bmatrix} = \begin{bmatrix} J \end{bmatrix}^{-1} \begin{bmatrix} P(1,1) \\ P(2,1) \\ P(3,1) \end{bmatrix} \quad (2.25)$$

Interpolation of total head field

$$H = H(\xi, \eta, \zeta) = N_1(\xi, \eta, \zeta) \cdot H_1 + \dots + N_8(\xi, \eta, \zeta) \cdot H_8 \quad (2.26)$$

Derivatives of total head field wrt  $x, y$  and  $z$  coordinates

$$\begin{aligned} H_{,x} &= N_{1,x} \cdot H_1 + \dots + N_{8,x} \cdot H_8 \\ H_{,y} &= N_{1,y} \cdot H_1 + \dots + N_{8,y} \cdot H_8 \\ H_{,z} &= N_{1,z} \cdot H_1 + \dots + N_{8,z} \cdot H_8 \end{aligned} \quad (2.27)$$

Numerical integration in  $\xi, \eta$  and  $\zeta$  coordinates

$$\int_V F(x, y, z) dx dy dz = \int_V F(\xi, \eta, \zeta) \cdot |J(\xi, \eta, \zeta)| d\xi d\eta d\zeta \quad (2.28)$$

$$= F_1(\xi_1, \eta_1, \zeta_1) \cdot |J_1| \cdot W_1 + \dots + F_8(\xi_8, \eta_8, \zeta_8) \cdot |J_8| \cdot W_8$$

Numerical integration of capacity matrix using 2x2x2 Gauss points

$$[c] = \sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 \lambda [N(\xi, \eta, \zeta)]^T \cdot [N(\xi, \eta, \zeta)] \cdot |J(\xi, \eta, \zeta)| \cdot L_i L_j L_k \quad (2.29)$$

Numerical integration of conductivity matrix using 2x2x2 points

$$[k] = \sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 (k_x [N, x(\xi, \eta, \zeta)]^T \cdot [N, x(\xi, \eta, \zeta)] \quad (2.30)$$

$$+ k_y [N, y(\xi, \eta, \zeta)]^T \cdot [N, y(\xi, \eta, \zeta)]$$

$$+ k_z [N, z(\xi, \eta, \zeta)]^T \cdot [N, z(\xi, \eta, \zeta)]) \cdot |J(\xi, \eta, \zeta)| \cdot L_i L_j L_k$$

Numerical integration of flow generation vector using 2x2x2 points

$$[\dot{q}_h] = \sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 \dot{q}_G \cdot [N(\xi, \eta, \zeta)]^T \cdot |J(\xi, \eta, \zeta)| \cdot L_i L_j L_k \quad (2.31)$$

Numerical integration of specified flow vector using 2x2 points

$$[\dot{q}_B] = \sum_{i=1}^2 \sum_{j=1}^2 f_B \cdot [N_s(r, t)]^T \cdot |J(r, t)| \cdot L_i L_j \quad (2.32)$$

$$[N_s] = [N_{s1} \ N_{s2} \ N_{s3} \ N_{s4}]$$

$r, t$  : Natural coordinate on element surface  
where boundary flux is specified

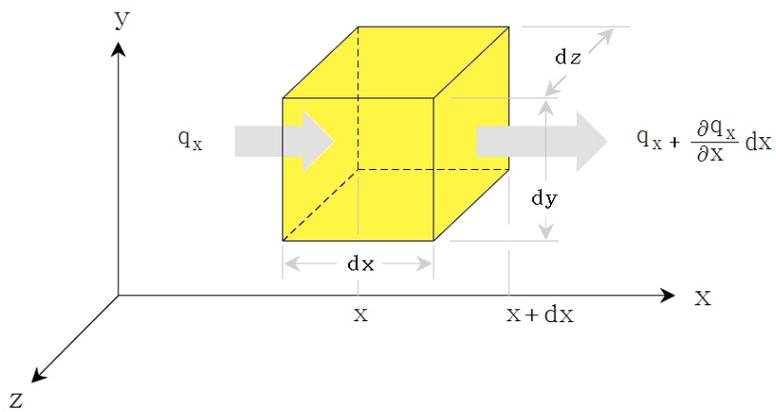


Figure 2.1 Flow in differential control volume



## SWCC Models

### 3.1 SWCC Models

#### 3.1.1 Introduction

SWCC represents Soil Water Characteristic Curve where unsaturated volumetric water content is expressed as a function of matric suction. Specific moisture capacity, which is required for the transient seepage analysis, is obtained by differentiating the volumetric water content with respect to matric suction.

Most empirical equations for the unsaturated hydraulic conductivity are obtained by relating to the soil water characteristic curves.

SMAP supports following four SWCC models:

- van Genuchten (1980)
- Fredlund and Xing (1994)
- Brutsaert (1966) and Gardner (1958)
- Simple Gardner (1958)

SWCC model parameters for the typical soils (sand, silt and clay) are presented in the following tables.

- Table 3.1 for van Genuchten (1980) and Leong & Rahardjo (1997)
- Table 3.2 for Fredlund and Xing (1994)
- Table 3.3 for Brutsaert (1966) and Gardner (1958)
- Table 3.4 for van Genuchten (1980) from Carsel & Parrish (1988)

### 3.1.2 van Genuchten (1980)

Volumetric water content for unsaturated soils is given by

$$\theta = \theta_r + \frac{(\theta_s - \theta_r)}{[1 + (a \psi)^n]^m} \quad (3.1)$$

where

$\psi$	Suction as water pressure or pressure head
$\theta$	Volumetric water content
$\theta_s$	Saturated volumetric water content
$\theta_r$	Residual volumetric water content
$a, n, m$	Material parameters from fitting data Default $m = 1 - 1/n$

Differentiation of water content with respect to suction

$$\frac{d\theta}{d\psi} = - \frac{(\theta_s - \theta_r) m n a (a \psi)^{n-1}}{[1 + (a \psi)^n]^{m+1}} \quad (3.2)$$

Specific moisture capacity ( $m_w$ ) for unsaturated soils is given by

$$\begin{aligned} m_w &= (d\theta/d\psi) (1/\gamma_w) && \text{when } \psi \text{ is water pressure head} \\ m_w &= (d\theta/d\psi) && \text{when } \psi \text{ is water pressure} \end{aligned} \quad (3.3)$$

where  $\gamma_w$  is unit weight of water

Permeability for unsaturated soils is given by

$$k = k_s \frac{(1 - (a \psi)^{n-1} [1 + (a \psi)^n]^{-m})^2}{[1 + (a \psi)^n]^{m/2}} \quad (3.4)$$

where  $k_s$  is saturated permeability.

### 3.1.3 Fredlund and Xing (1994)

Volumetric water content for unsaturated soils is given by

$$\theta = C(\psi) \frac{\theta_s}{\left( \ln \left[ e + \left( \frac{\psi}{a} \right)^n \right] \right)^m} \quad (3.5)$$

where

$\psi$	Suction as water pressure or pressure head
$\psi_r$	Suction at residual water content
$\theta$	Volumetric water content
$\theta_s$	Saturated volumetric water content
$a, n, m$	Material parameters from fitting data

$$C(\psi) = 1 - \frac{\ln(1 + \psi/\psi_r)}{\ln(1 + 10^6/\psi_r)} \quad (3.6)$$

Differentiation of water content with respect to suction

$$\frac{d\theta}{d\psi} = C' \frac{\theta_s}{\left( \ln \left[ e + \left( \frac{\psi}{a} \right)^n \right] \right)^m} - C \frac{\theta_s}{\left( \ln \left[ e + \left( \frac{\psi}{a} \right)^n \right] \right)^{m+1}} \frac{m n (\psi/a)^{n-1}}{a \left[ e + \left( \frac{\psi}{a} \right)^n \right]} \quad (3.7)$$

$$C'(\psi) = - \frac{1}{(\psi_r + \psi) \ln [1 + 10^6/\psi_r]} \quad (3.8)$$

Unsaturated relative permeability is given by

$$k_r = \frac{\int_{\ln(\psi)}^b e^{-y} [\theta(e^y) - \theta(\psi)] \theta'(e^y) dy}{\int_{\ln(\psi_{aev})}^b e^{-y} [\theta(e^y) - \theta_s] \theta'(e^y) dy} \quad (3.9)$$

$\psi_{aev}$  = air-entry value of suction

$b = \ln(1,000,000)$

Leong and Rahardjo (1997) proposed simplified form of unsaturated hydraulic conductivity by assuming  $C(\psi) = 1$ .

$$k = \frac{k_s}{\left( \ln \left[ e + \left( \frac{\psi}{a} \right)^n \right] \right)^m} \quad (3.10)$$

where  $k_s$  is permeability at saturation.

### 3.1.4 Brutsaert (1966) and Gardner (1958)

Unsaturated volumetric water content is given by Brutsaert (1966)

$$\theta = \theta_r + (\theta_s - \theta_r) \frac{A_1}{A_1 + (\psi)^{n_1}} \quad (3.11)$$

where

$\psi$	Suction as water pressure head
$\theta$	Volumetric water content
$\theta_s$	Saturated volumetric water content
$\theta_r$	Residual volumetric water content
$A_1, n_1$	Material parameters from fitting data

Differentiation of water content with respect to suction

$$\frac{d\theta}{d\psi} = - (\theta_s - \theta_r) \frac{A_1 n_1 (\psi)^{n_1-1}}{\left[ A_1 + (\psi)^{n_1} \right]^2} \quad (3.12)$$

Unsaturated permeability is given by Gardner (1958)

$$k = k_s \frac{A_2}{A_2 + (\psi)^{n_2}} \quad (3.13)$$

where

$k_s$	Permeability at saturation.
$A_2, n_2$	Material parameters from fitting data

### 3.1.5 Simple Gardner (1958)

This Simple Gardner equation is used for Verification Problem 2.

Volumetric water content for unsaturated soils is given by

$$\theta = \theta_r + (\theta_s - \theta_r) e^{-\alpha \psi} \quad \psi > 0 \quad (3.14)$$

where

$\psi$	Suction as water pressure head
$\theta$	Volumetric water content
$\theta_s$	Saturated volumetric water content
$\theta_r$	Residual volumetric water content
$\alpha$	Material parameters

Differentiation of water content with respect to suction head

$$\frac{d\theta}{d\psi} = -(\theta_s - \theta_r) \alpha e^{-\alpha \psi} \quad (3.15)$$

Specific moisture capacity ( $m_w$ ) for unsaturated soils is given by

$$m_w = (d\theta / d\psi) (1 / \gamma_w) \quad (3.16)$$

where  $\gamma_w$  is unit weight of water

Permeability for unsaturated soils is given by

$$k = k_s e^{-\alpha \psi} \quad (3.17)$$

where  $k_s$  is saturated permeability.

And  $\alpha$  is the same as that used in Equation 3.14 for water content.

Table 3.1 SMCC model parameters from Gui et al, 2011 (Ref 6)

Soil Type	$k_s$ (m/d)	$\theta_s$	van Genuchten (1980) $m = 1-1/n$		Leong & Rahardjo (1997)		
			a (kPa <sup>-1</sup> )	n	a (kPa)	n	m
CL	$1.29 \cdot 10^{-10}$	0.45	0.016	1.180	70.54	1.211	0.4620
ML	$2.45 \cdot 10^{-8}$	0.37	0.0172	1.209	104.0	1.016	0.5904
SM	$7 \cdot 10^{-6}$	0.35	0.0682	1.411	21.42	1.734	0.8811

CL: Lean Clay   ML : Silt   SM : Silty Sand  
 $k_s$  : Saturated permeability  
 $\theta_s$  : Saturated volumetric water content

Table 3.2 SMCC parameters from Fredlund et al, 1994 (Ref 3)

Soil Type	$k_s \times 10^6$ (m/s)	$\theta_s$	a	n	m	$P_r$ (kPa)
Touchet silt loam	----	0.43	8.34	9.90	0.44	30
Columbia sandy loam	----	0.458	6.01	11.86	0.36	30
Yolo light clay	0.123	0.375	2.70	2.05	0.36	100
Guelph loam (Drying)	3.917	0.52	5.61	2.24	0.40	300
Guelph loam (Wetting)	0.7	0.43	3.12	4.86	0.23	100
Superstition sand	18.3	----	2.77	11.20	0.45	300

Table 3.3 SMCC model parameters from Mavroulidou, 1999 (Ref 8)

Soil Type	$k_s$ (m/d)	$\theta_s$	$\theta_r$	Brutsaert (1966)		Gardner (1958)	
				$A_1$ (m)	$n_1$	$A_2$ (m)	$n_2$
Silty Sand	8.4	0.3	0.0	0.0634	2.9	0.0003	5.0
Touchet Silt	0.432	0.469	0.127	1.505	2.849	0.3302	5.192
Jurong Clay	$6.74 \cdot 10^{-4}$	0.394	0.320	1.3705	0.5876	0.0011	2.0

Silty Sand : Vauclin et al (1976)

Touchet Silt : Brooks and Corey (1966)

Jurong Clay : Leong and Rahardjo (1995)

$\theta_r$  : Residual volumetric water content

Table 3.4 van Genuchten parameters from Carsel & Parrish, 1988 [Ref 2]

Soil Type	$k_s$ (m/s)	$\theta_s$	$\theta_r$	$a$ (kPa <sup>-1</sup> )	$n$
Sand	8.25E-05	0.43	0.045	1.477	2.68
Loamy Sand	4.05E-05	0.41	0.057	1.264	2.28
Sandy Loam	1.22E-05	0.41	0.065	0.7645	1.89
Sandy Clay Loam	3.64E-06	0.39	0.100	0.6013	1.48
Loam	2.89E-06	0.43	0.078	0.3670	1.56
Silt Loam	1.25E-06	0.45	0.067	0.2039	1.41
Clay Loam	7.22E-07	0.41	0.095	0.1937	1.31
Silt	6.94E-07	0.46	0.034	0.1631	1.37
Clay	5.55E-07	0.38	0.068	0.08155	1.09
Sandy Clay	3.33E-07	0.38	0.100	0.2753	1.23
Silty Clay Loam	1.94E-07	0.43	0.089	0.1019	1.23
Silty Clay	5.55E-08	0.36	0.070	0.051	1.09

Note:  $m = 1 - 1/n$

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